SLEEPING SICKNESS

A RECORD OF FOUR YEARS' WAR AGAINST IT IN

THE ISLAND OF PRINCIPE

BY

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A RECORD OF FOUR YEARS' WAR AGAINST IT IN PRINCIPE, PORTUGUESE WEST AFRICA

PANORAMA OF THE WESTERN PORTION OF THE ISLAND OF PRINCIPE
TAKEN FROM THE PONTA DO SOL, ROÇA SUNDY, NORTHERN ZONE OF ISLAND

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GLOSSARY OF LOCAL AND SPECIAL TERMS USED IN THE ISLANDS OF SAN THOMÉ AND PRINCIPE

Assentada—A more or less flat or gently sloping formation of land, lying generally between or on the skirts of hills.

Batuque—A negro festival, with native music and dances.

Budo-Judeu—The thin reddish lateritic soil common on the islands and mainland of the West African coast and in other regions of the tropics.

Cachaça—A kind of rum, distilled locally.

Capim, Capina.—Grass and herbaceous undergrowth.

Capinar—The operation of rooting out the *capim.*

Capoeirão—A secondary growth, bushy or aroid, springing up where *obó*, or virgin forest, has been felled and cleared.

Catana—See *Machim.*

Cavalête—A narrow, steep-sided spur, springing from an upland plateau.

Escudo—The Portuguese currency unit, formerly known as *milreis.* Nominally equivalent to a dollar, but at present rate of exchange worth about 3s. 1d.

Forro—A term variously defined. Was originally applied to the island-born peasant proprietor, but is now resented by him as implying descent from the class of freedmen. *Filho da terra* is accepted as an unobjectionable synonym.

Gravana, Gravanito—Respectively the dry season proper (June to September), and the break in the rains occurring, or expected to occur, in January.

Groto—A deep valley with precipitous sides, forming the interval between two *cavalêtes* (see above).

Lagaia—A wild civet-cat, common on the island, resembling the Indian "Toddy-cat."

Machim—The type of hatchet used by coloured labourers for general work in the field. Very similar to the Gurkha *kukri* and the Burmese *dha.*

Obó—Virgin forest, composed of tall trees and innumerable lianas.

Oga-Oga—A rank grass growing in clumps, closely akin to the *lalang* of Ceylon and Malaya.

Praia—A sandy beach.

Roça—Literally a clearing, but locally applied to an estate or plantation (of coffee, cacao, etc.).

Roceiro—A planter or estate-owner (from *roça*).

Sanzala—Native labourers' barracks or lines.

Serviçal, pl. *Serviçaes*—An African contracted labourer.

Terreiro—A barbacue or open space for drying the cacao-bean, etc. May include the buildings enclosing it so as to form a quadrangle.

Tonga—Synonymous with *forro*, but restricted to island-born children of serviçal parentage, who grow up on the estates where they are born, and ultimately serve as uncontracted labourers.

Uba—Grass lands, fenced in so as to form cattle-ranches.

SLEEPING SICKNESS

FINAL REPORT OF THE MISSION TO THE ISLAND OF PRINCIPE (1912—1914)

PART I

MAIN FACTS CONCERNING THE EPIDEMIC, AND NATURAL CONDITIONS OF THE ISLAND OF PRINCIPE

History of the Epidemic.

Sleeping sickness is known to have been on the increase among the native population of the West African Coast ever since 1754, the year in which J. Atkins, a British naval surgeon, gave us the earliest information regarding it.

In 1803 Winterbottom noted its existence among the natives of the coast round the Bight of Benin. Clark, a missionary, in 1840 observed it among the natives of the Gold Coast and of Sierra Leone; Davis studied it in the basin of the Niger between 1854 and 1857; Anche Charles and Griffon du Bellay found it in the Congo in 1863-64, and Santelli in 1858 on the Kru Coast.

In Angola, our knowledge of the disease dates from 1871, where it began by invading the basin of the Quanza. The invasion of the Congo basin towards the interior appears to have taken place a little earlier than this, and not to have passed beyond Stanley Pool until 1887, although native tradition, according to Rodhain, gives the disease as of ancient date in the region of the lower Ubanghi.

It is thus quite credible that sleeping sickness in a more or less endemic form has existed on the West Coast, between the rivers Senegal and Congo, for over a century. In those earlier days, and all along the seaboard up to the middle of last century, there used to be an active traffic in slaves destined to people and develop the various American colonies—a circumstance which led to the diffusion of a large

number of clinical cases of the disease throughout the countries served by those migratory movements.

To what extent the slave trade helped to spread the malady in the form of imported cases may be estimated from the fact that in Martinique, in 1869, Guérin was able, for the purpose of his thesis, to collect full histories, with anatomico-pathological facts, of no less than 148 cases among negroes, natives of the West African Coast.

In the islands of San Thomé and Principe, colonized to a great extent from the Gaboon and the Congo, and for many years utilized as an entrepôt for slaves destined for Brazil, it is natural that carriers of the disease should long have been known, seeing that in 1871 Dr. Ferreira Ribeiro made his interesting and historic communication to the Society of Medical Sciences in Lisbon, recording the presence of the malady in both islands.

Considering the very small range of diffusion of the *tzetze* by the agency of maritime transport, it is reasonable to suppose that the insect, which is also a native of the Gaboon, was only introduced into Principe much later in the day, by which time cases of the disease had become numerous. According to tradition, it was about 1825 that the vessels used alternately as transports for slaves and for cattle were the vehicle of its importation. Thus Principe, which had become an important market for cattle, became a local focus for the glossina. Yet San Thomé has up to the present day maintained its immunity.

In 1877, following the introduction into the island of fresh labour levies from Cazengo and the banks of the Quanza, the epidemic began to manifest itself on an alarming scale. Local conditions favourable to dissemination must then have been in existence, superadding to the autocthonous cases the high figure of the exotic cases.

About 1885, according to the testimony of the older European inhabitants, the mortality among the serviçaes of the northern part of the island was frightful, and from 1890 onwards the increase was such as to constitute the disease a veritable scourge, ranking as an insuperable obstacle to the progress of agriculture in the colony.

In the year 1894 the Roça Porto Real brought from Angola some 600 serviçaes, almost all from the Cazengo region. At the end of five years these men had completely disappeared, almost all of them slain by this disease. Some had no doubt brought the germs of it with them; but others had contracted it locally. According to the statements of eyewitnesses, the labourers composing this levy used to die at the rate of ten a day.

When the first Portuguese Medical Mission, under Professor Annibal Bettencourt, visited the island in 1901, the hospital of the Roça Sundy had a daily average of 10 cases under treatment, displaying the clinical symptoms of the malady; this out of a labouring establishment of 400 souls. The census of the previous year (1900) showed a mortality of 48, out of a total population of 4,747, besides 181 deaths figuring under the vague heading of anæmia. Of the latter it may be hazarded that at least two-thirds were sufferers from this malady, microscopic diagnosis of which was not then available. Thus, in that year the mortality from sleeping sickness must have been some 35 per mille, or one-fifth of the total mortality.

From 1902 to 1913 numerical data of the mortality of the island population are available. If up to 1907 the figures cannot be accepted as rigorously accurate as regards human trypanosomiasis, from 1908 onwards they are reasonably correct, and from 1910, when the diagnosis of the disease began to be verified microscopically, they are almost unchallengeable.

From the figures given in the following table, it will be seen that the annual average mortality between 1902 and 1913 from this disease has been 210, or 5·6 per cent. of the whole population. The average of general mortality during the same period being 571, or 15·5 per cent., it follows that this disease alone is answerable for rather more than one-third of the total deaths.

TABLE I.—RÉSUMÉ OF STATISTICS OF GENERAL MORTALITY AND OF MORTALITY FROM SLEEPING SICKNESS IN PRINCIPE DURING THE YEARS 1902-1913.

Years.	*Population of the Island.*	*General Mortality.*	*Deaths from Sleeping Sickness.*	*General Mortality.*	*Deaths from Sleeping Sickness.*
				Per Cent.	Per Cent.
1902	4,036	891	246	22·1	6·1
1903	3,848	798	324	20·7	8·4
1904	3,840	628	249	16·3	6·5
1905	3,945	685	284	17·3	7·2
1906	3,288	645	279	19·6	8·3
1907	2,995	447	161	14·9	5·4
1908	3,631	499	137	13·6	3·9
1909	3,488	575	134	16·4	3·8
1910	3,663	481	160	13·1	4·4
1911	3,815	472	251	12·3	6·5
1912	4,309	386	167	8·9	3·8
1913	4,938	344	133	6·9	2·7

If we treat the above statistics as relating to two separate periods—namely, from 1902 to 1906-07, and from 1907-08 to 1913—the figures of the latter deserving more confidence than those of the former, we shall see that the general mortality, and the deaths from this disease, were respectively 19·2 and 7·34 per cent. for the earlier period, and 12·3 and 4·35 per cent. for the later. The improvement these figures represent is not merely the translation into results of much sanitary work done since 1911, but is also an index to the progress made in respect of medical treatment given to the labouring population. The systematic administration of atoxyl, among other things, has proved a distinct boon to the island as a whole, and this is a matter the credit of which is due to the labours of the second medical mission (1907-08) under Correia Mendes.

According to the statistics, the mortality for the period 1902-1913 from sleeping sickness runs to a total of 2,525, or, say, an average of 2,100 deaths per decennium. As the population of the island during that period averaged, approximately, 3,800 souls, it follows that Principe was losing in the course of every twenty years a number of lives in excess of its total population. The heavy general mortality of the island in certain years—*e.g.*, 1902 and 1903, when it reached 22·1 and 20·7 per cent. respectively, would scarcely be conceivable in the absence of some epidemic disease of a high degree of virulence. It suggests that sleeping sickness must have been responsible for a far larger number of deaths than have been ascribed to it in the obituary registers of the period.

There is nothing surprising in this. Labour used then to be imported from the infected regions of Angola, and carriers of the disease, swelling the normal mortality, must constantly have been among the arrivals. Allowance, no doubt, should be made for the converse—for repatriations of infected persons who may have left the island to die elsewhere. But this cannot seriously weaken the general conclusion, for through a variety of circumstances the factor must have been relatively insignificant.

In estimating the scope of the sanitary problem created for the colony by the endemic disease, it is especially interesting to note the proportion of trypanosome-carriers detected by means of microscopic examination of their blood at various dates, as shown thus:

1907.	General percentage of persons attacked	..	..	26·0	per	cent.
1911.	,, ,, ,,	..	..	18·5	,,	
1913.	,, ,, ,,	..	..	7·7	,,	
1914.	,, ,, ,,	..	..	0·64	,,	

In 1907-1911, before the benefits of the present sanitary campaign had had time to manifest themselves, condensed preparations of blood had revealed under the microscope the presence of trypanosomes in the case of an average of 22·2 per cent. of the inhabitants. In other words, more than one-fifth of the total population was found to be infected with the disease.

We must add here, with reference to the same period, that the native population proper, the permanent inhabitants of the island, did not then exceed one-tenth of the whole, the remaining nine-tenths being made up of labourers engaged for work on the plantations. The latter were almost entirely imported, and only remained for the period of their contract. The probability of their acquiring the disease decreased with the shortening of their term of residence. From this it will be seen that, in spite of its floating character, the population of this island has been very severely scourged indeed by this deadly plague.

The native of the island, in virtue, perhaps, of a partial immunity due to natural selection operating throughout the course of many years, or perhaps of a lesser degree of susceptibility, or again, possibly, of the protection derived from his personally sedentary habits, has of late years contributed a reduced percentage to the roll of infected cases; thus, in 1913 he only figured to the extent of 2·3 per cent. in the general percentage of 7·7 for the whole island population.

In earlier times, however, his class seems to have paid a pretty heavy toll to the disease. The autocthonous population in 1885 was estimated at 3,000 souls, but by 1900 its numbers had fallen to 800, and by 1907, according to Correia Mendes, to only 350 all told. But subsequently, under improved sanitary conditions, it began to increase, so that in 1913 it had risen to 550, and in the following year, 1914, it stood at 668 in the census of the island.

Apart from purely hygienic considerations, the economic problem of the island, of late years intimately associated with the endemic, deserves a few words of comment. This little colony is mainly important on account of the agricultural enterprises carried on within it, these having for their almost exclusive object the cultivation of cacao. This means labour, and labour means importation of labourers from the outside colonies where they are available, which in its turn means weighty legal and pecuniary obligations falling upon the proprietors and estates who engage those labourers. The native proper being innately averse from hard work, the immigrant labourer thus becomes

the chief element in the wealth of the island—the axis, so to speak, upon which all its internal economic life revolves.

The expenses incurred in the introduction of each serviçal from Angola run to 100 escudos approximately, or £20; the annual cost of his maintenance, medical attendance, clothing, etc., may be taken at 90 escudos, or £18, over and above his actual wages. On the other side of the account, every labourer may be regarded as contributing towards the value of the produce exported a share not less than 100 escudos annually; and taking the total cultivated area in the island at 90 square kilometres, he may be looked upon as a guarantee for the regular cultivation of, roughly, $2\frac{1}{2}$ hectares of land.

The mean mortality, when it stood at 210 per annum (and was then probably understated), represented an annual loss in hard cash of not less than 21,000 escudos (£4,200), seeing that it entailed the introduction of an equivalent number of hands to take the places of those who had thus perished. And when, owing to considerations of public health, this replacement was impracticable, the blanks in the labour force represented the temporary passing out of cultivation of some 500 hectares of productive land.

And that was not all; the planter being bound to provide for the treatment of his sick hands, and the disease being for the most part an incurable one though running a long chronic course, fresh burdens in a different form fell upon him, to the aggravation of his financial difficulties in general. Thus, it is not to be wondered at that many of the estates should have been brought to the verge of ruin.

According to data furnished by the managements of the various properties, the daily mean of sleeping sickness cases under treatment in the hospitals during the period 1907-1913 exceeded 50. The annual expenditure this involved was 5,500 escudos, or £1,100 in respect of this class of sufferer alone, not to mention a number of out-patients, exceeding 450, who had periodically to be treated with injections of atoxyl, and whose labour, from the point of view of the employer, was of little or no value.

From 1907 onwards, the consumption of atoxyl in the island amounted in round numbers to 45 kilogrammes, representing a cost not far short of 5,000 escudos (£1,000). According to the posology of this drug, as established and adopted in general practice in the light of the labours of the Correia Mendes Mission, this quantity is, at the lowest estimate, equivalent to 75,000 partial doses of 0·6 gramme.

Let us sum up all the consequences of the endemic. We have: The incessant loss of life; the enormous risk to both the European and the African colonist; the difficulties in the way of getting labour; the heavy charges falling upon agricultural finance; the uphill work of maintaining the plantations at their maximum of output. All these circumstances will convey some idea of the perilous situation created for the colony by this scourge of sleeping sickness, and of the life of tribulation through which for the last twenty years it has been passing. They amply justified the Government of Portugal in taking into serious consideration proposals made for the definite abandonment of the island.

Previous Labours of Portuguese Physicians upon Sleeping Sickness in Principe.

The wide extension of sleeping sickness throughout Angola, where from 1871 onwards it had worked much havoc, led the Government of Portugal, in 1901, to send a commission of inquiry into the circumstances to the African West Coast. This was the first of its kind in any of our colonies. Its members were Annibal Bettencourt, chief of the Mission, Ayres Kopke, Gomes de Resende, and Correia Mendes.

The work of that Mission, done at a period when the true etiology of the disease and the mode of its propagation were yet unknown, though out of date in the light of present-day knowledge of its prophylaxis, is nevertheless noteworthy for the rigour of its clinical observations and the development of its anatomico-pathological studies.

The Mission merely paid a passing visit to Principe in May, 1901, but in its final report six clinical cases of the malady as seen there are described, all, we imagine, taken from among the workers on the Roça Sundy.

The second Mission for the study of the disease, directed by Correia Mendes, its other members being Damas Mora, Silva Monteiro, and Bruto da Costa, all medical men belonging to the colonial service, remained in the island throughout the years 1907 and 1908. To this Mission we owe the essential elements for the sanitary campaign just concluded by the present Mission.

The programme of the labours of the Correia Mendes Mission contained two distinct sections in respect of either of which well-founded conclusions might be arrived at.

As the mystery of the causal agent of infection had been solved since 1903, thanks to the contributions of Dutton, Castellani, and Bruce, the rôle of the glossina in its propagation was now known; the Portuguese Mission endeavoured in the first instance to clear up in detail the conditions of the local epidemic so as to arrive at the rules of prophylaxis applicable thereto. The distribution of the malady in the island, a wide and complete study of the hematologic parasitology of its inhabitants and of its mammalian fauna, as well as the habits and distribution of the *Glossina palpalis*, the classification of its foci and the determination of the rules governing a plan of direct attack on it, formed material intelligently handled by that Mission in the course of its fruitful labours. Its conclusions thus rendered possible the control of a scourge which had for so long afflicted the island.

Guided at the same time by the indications of the School of Tropical Medicine at Lisbon, where, since 1905, Professor Kopke had been experimenting with atoxyl and had obtained encouraging results, the Mission commenced a series of systematic experiments in the island so as to determine the most efficacious rules for the application of this drug, but at the same time tried other drugs possessed of trypanosomicidal properties. From these experiments was evolved the method of double injections of 0·5 or 0·6 gramme of atoxyl at 48-hour intervals, repeated fortnightly over six months of the year. To this may be ascribed a fair number of cures effected in the island. And to the general use of atoxyl, though indeed often employed irregularly, is also due the fall in the mortality from sleeping sickness after the year 1907.

The Mission, moreover, when selecting a method for administering atoxyl, kept in view the prophylactic range of its use, rendering the sufferers, when not susceptible of cure, as little dangerous to others as possible, by causing the disappearance of the parasite from the peripheral blood; though at the same time they bore in mind the risk, clearly pointed out by Kopke, of bringing into existence in the island a race of trypanosomes resistent to arsenic.

Geography and Natural Conditions of the Island of Principe.

Situation.—The island lies well inside the Gulf of Guinea, between 1° 32′ and 1° 41′ N. Lat., and between 7° 19′ and 7° 27′ E. Long., Meridian of Greenwich. The nearest point of African coast, Cape

Fig. 1 —View of the Bay of Santo Antonio, from the Roça Sant' Anna, with the Town in the Background.

S. Juan, in Spanish Guinea, is about 200 kilometres distant. Cape Lopez, farther to the south, is 240 kilometres off.

The four islands of the group to which it belongs—Fernando Pó, Principe, S. Thomé, and Annobon—lie in a straight line running north-east to south-west, and this line, if prolonged to the north-east, would strike the Peak of Kamerun in the late German colony of that name.

The distance from Principe to S. Thomé is 130 kilometres, and to Fernando Pó 200 kilometres; the last-named island is only 40 kilometres from the Kamerun coast.

Form and Dimensions.—The island of Principe has its greatest length from north to south, approximately 17 kilometres, measured from the shore of the islet of Bonbon on the north to that of Pico Negro on the south. Its greatest breadth, measured from the Point of Garça on the east to that of Iola on the west, is 10 kilometres.

The geometric axis of the island takes a north-east to south-west direction, and may be considered as starting from the outer shore of the islet of Mosteiros on the north-east to the Point of Mamas on the south-west, a distance of 18 kilometres.

Its total area is computed at 126 square kilometres.

The whole coast-line of the island is capriciously indented, narrow projections of land constantly alternating with more or less deeply re-entrant fiords. The natural ports of the island are the Bay of Santo Antonio, and the so-called West Bay, or Bay of Agulhas. The former is situated in the north-east section of the island, its mouth open to the east, 2 kilometres wide between Point Capitão (Belmonte) on the north, and Praia Salgada on the south. From its entrance it gradually narrows down to the landward, terminating in a cul-de-sac at the town of Santo Antonio, between the mouths of the Papagaio and the Ribeira dos Frades.

The axis of the bay measures 3·5 kilometres, and curves somewhat, its concavity towards the south-east; as a port it is perfectly sheltered from the prevailing winds of the south and south-west, the disturbance of the sea known locally as *calema* only occurring with any frequency during the so-called *gravana* (dry season between June and September).

West Bay (Baia do Oeste) is a wide anchorage on the other side of the island, in a spacious re-entrant of the coast-line between Point Iola and the Focinho do Cão. It is open to the north-west, but the peninsula

Fig. 2.—View of the Hospital on the South Shore of Santo Antonio Bay.

of Focinho do Cão, which runs south-east to north-west, protects it from the winds blowing from the southern quarter.

At present the sole port of call is that of the Bay of Santo Antonio. The West Bay, however, has a history of its own, dating from the days of the slave trade, and later on it used to be frequented by the British war-vessels engaged in the suppression of that traffic.

On the northern coast, near the mouth of the Ribeira Izé, just under the lee of the Point Hora, there is a little anchorage where in former times slaves and cattle from the Gaboon used to be disembarked. Tradition has it that their landing used to be effected by means of big primitive canoes hollowed out of the trunks of colossal trees and flattened at the prow so as to afford a practicable gangway for men and animals to walk ashore by. Along with these, in all probability, the first glossins must have invaded the island at this point.

Orography.—The soil of Principe, like that of San Thomé, is of volcanic origin; the surface is very much broken up into heights and hollows, but there are no peaks of any great elevation. The highest are in the south, the more important rising to 800 and 900 metres. The peak of Papagaio, in the centre of the island, overhanging the town of Santo Antonio, appears not to exceed 700 metres in height.

The mountain ranges of the island may be resolved into two separate systems—the chain of the Papagaio, and the group of peaks in the south. The former is made up of a series of elevations, culminating in the peak to which it owes its name. It begins at Oqué Nazareth, in the centre of the island, and runs down to its south-west angle (Ponta das Mamas) in a north-east to south-west direction. The peaks of Fundão, João Dias, Meza, Barriga Branca, and As Mamas, all belong to this system. The second system is that of the southern *massif*, and describes a semicircle in the south-east corner of the island, following the curve of the coast-line, but with its convexity turned towards the north-east. In its concavity it embraces practically the whole of the lands under cultivation by the Companhia da Ilha do Principe. The central part of this system is formed by two great groups of hills, one to the north-east, the other to the south-west, separated by a neck of abrupt watersheds in which the River Papagaio rises.

These clumps of hills break up into various peaks, rising one over the other. They culminate, to the north-east, above the headquarters of the Roça Infante D. Henrique, in the Pico Negro, and to the west of this, on the coastward group, in the Pico Pae Adão. On their southern

Fig. 3.—View of the South-West Point of the Island (Point Mãe Baleia), taken from Roça Abeade, showing the Peak of Duas Cabeças and Caroço Islet.

aspect these peaks rise almost vertically like veritable walls, descending less abruptly on the other side towards the basins of the Papagaio and the Banzú. Seen from the north, they display a very capricious perspective, the giant profile of one of them, picturesquely styled the Peak of Father Adam (Pico de Pae Adão) being specially remarkable.

To the east the great group of the southern peak region runs out in a long series of hills to the point known as Duas Cabeças, a double headland. A spur runs out from it to the Pico Negro, the whole forming a hilltop region serving as the watershed, east and west, of the peninsula of Neves Ferreira.

The *massif* of the Picos do Sul, standing forth as a barrier to the southerly winds prevailing throughout the year, and thus intercepting the great volume of moisture brought over by these in the rainy season, acts as the chief centre of precipitation for the island. From it radiate most of the important watercourses, some flowing south, others west, and one, the Rio Papagaio, carrying a quite considerable volume of water eastward to the coast.

These two systems are almost contiguous in the centre of the island, and are divided one from the other only by the valley of the Papagaio, but they gradually diverge towards the south, and end, one at the Ponta das Mamas, the other at the Pico Négro, a distance of 5 kilometres apart in a straight line. In this intermediate zone, triangular with its base to the south, the spurs of the two ranges more or less interlock. The region is not easily accessible, being rough and broken in contour, and is to this day covered with virgin forest.

The varied configuration of the island allows us to regard it as composed of three zones, appreciably differing one from another in climatic characteristics, in healthiness, and markedly in appropriateness to cultivation. These are the northern, the central, and the southern zones.

The first-named, having as its southern limit a line joining the Ponta de Marrocos with the Praia Caixão, is distinguished by the prevalence of plateaux varying in altitude from 100 to 150 metres, the land descending rapidly from their edge towards the marginal line, along the beds of the streams. The surface of these plateaux is at best only undulating, and they are flanked by narrow spurs or underfeatures diverging in all directions.

The greater of these plateaux occupies a large portion of this zone, extending from the Roça Praia Inhame as far as Sundy, and it measures

Fig. 4.—Duas Cabeças Peak, from the South: from Roça Infante D. Henrique.

7·5 kilometres from east-north-east to west-south-west; its greatest breadth is 2·5 kilometres on the west, between Sundy and Pincaté. The *assentada* of Montalvão, a part of the Roças Praia Inhame and Santa Anna, the central portion of Sundy, the Pincaté section of the Roça Porto Real, all belong to this formation.

To the north and west the ground falls almost abruptly to the coast; on the Sundy estate, for instance, the descent is almost perpendicular at certain points, dropping vertically either on the skirting slopes or direct upon the cliffs of the coast. Between the Ribeira Izé and the Praia (beach) das Burras the intermediate strip of land widens and the plateau reaches out to the coast upon narrow spurs (*cavalêtes*) which often end abruptly over the sea, these alternating with deep gullies (*grótas*) through which the surface water of the plateau and its flanks finds an exit. On their upper surface these spurs are sometimes only a few metres broad, and in their turn send out secondary ramifications separated one from another by ravines; these typical formations, abundantly represented in the formation of the island, are what in local parlance we term *cavalêtes* and *grótas*.

On the south this plateau is bounded, first by the northern shore of the bay, thence by the valley of the Ribeira dos Frades; on the west it dips over the valley of the Rio Bacharel, which separates it from the *assentada* of San Joaquim. A series of hills, the Oqué Gaspar, the Pincaté, and Montalegre, support its southern watershed. Between the basin of the Ribeira dos Frades, which in its upper course is known as the Manoel Affonso, and that of the Rio Bacharel, which, too, is styled the Ribeira Corvão, the northern plateau of the island runs up to the hill of Oqué Nazareth. This plateau may be regarded as the continuation of the Papagaio cordillera.

The small plateaux of San Joaquim and Santo-Christo-Nova Estrella, the former lying between the valleys of the Bacharel and Banzú, in the east of the island, and the latter to the south of the bay of Santo Antonio, are both of very limited area, and orographically very similar one to the other.

The central zone of the island is formed by the slopes which fall more or less rapidly to the seaboard on the west, and on the east to the valley of the Rio Papagaio. The peaks of the Papagaio range form its dorsal column. These spring abruptly out of the ground as great basaltic masses more or less tapering in shape, some of them, such as the Devil's Finger (Dedo do Diabo) and the Pico João Dias Filho, being

Fig. 5.—Pico Negro, Southern Side, from Roça Infante D. Henrique.

almost needle-shaped. From the foot of these boulders the ground folds into flanks, lips, and hillocks, broken by the beds of torrents from the central upland, and drops, at times suddenly, at times gently, down to the lowland line.

It is a zone of varied altitudes and of broken conformation, but broad, undulating slopes predominate. Like the rest of the island, it is well watered, being traversed by numerous streams rising as a rule in the mountainous region of the Picos do Sul, and crossing the cordillera of the Papagaio by means of veritable cañons.

What specially mark out the southern zone are its slopes with southern exposure surmounted by the great *massif* of the Picos; this zone is composed of a band of country measuring from 1 to 4 kilometres in breadth, falling at a steep angle, and furrowed by a great number of torrents which break over rocky beds and describe fantastically sinuous curves all the way down to the sea. The seaboard here is singularly indented, and the whole region lies exposed to the southerly winds—a circumstance which, as we shall shortly see, explains certain climatic peculiarities of this part of the island.

Hydrography.—The superficial running waters of the island may be divided into two groups: rivers and brooks springing from the great southern mountain system and supplemented here and there by waters from the slopes of the Papagaio chain, and watercourses taking their rise on the plateaux.

The first group comprises the rivers of greater importance in the island, the springs of which are abundantly fed by the copious rains falling almost uninterruptedly in the southern zone. Some of these rivers discharge into the sea on the southern coast, but two, the Tubarão and the Banzú, reach it on the western, while the Papagaio falls into the bay of Santo Antonio on the eastern coast.

The rivers of the southern watershed are numerous and torrential, swelling enormously during the heavier bursts of rainfall. The central mountain system of the Neves Ferreira peninsula, running from north to south, separates them into two subgroups—the eastern, to which belong the rivers flowing in a somewhat south-easterly direction, and the western, formed of those which seek their outlet in the south-west.

As noteworthy in this minor hydrographic system, let us mention the Rio Papagaio, the Banzú, and the Conde de Mendia brook, or Ribeira Porco. The first-named is perhaps the longest of these streams (9 to 10 kilometres); it rises among rocks, but for the lower two-thirds

Fig. 6.—Ribeira Conde de Mendia, or Ribeira Porco, in the Roça Infante D. Henrique.

of its course it runs between banks of low and marshy land; the second conveys to the sea a greater quantity of water, as it is swollen by an important affluent rising from the foot of the peak of Papagaio; the last-named flows entirely within the great forest of the south.

The rivers rising on the plateaux or on the flanks of them are as a rule less important than those of the first group. Among them we may mention the Dumú Izé, the Bacharel, and the Ribeira dos Frades. The first has a long course from south to north in the western section of the plateau of Montalvão-Ponta do Sol, and begins by winding sluggishly between low, marshy banks. It is indeed in itself a mere series of swamps until it enters a more rapidly falling channel hollowed out at the bottom of the broad valley of the Ribeira Izé. The eastern side of that valley belongs to the Roça Sundy, the western to the Roças Azeitona and Ribeira Izé. In the upper part of its course the stream bears the appropriate name of Ribeira Lama (Mud Brook).

Many watercourses rising in the upland region form picturesque cascades when they reach its edges, often flinging themselves from great heights so as to reach the lower levels on their way down to the coast. In this category will be found the cascade of the Rio Bacharel, measuring approximately 50 metres in height, where its waters discharge themselves over a wall of basalt and fall by successive steps, hurling themselves over the ragged projections of their rocky bed, and breaking up into innumerable smaller falls, the general effect being marvellous.

All round the central part of the Sundy estate, where the fall from the plateau is abrupt, waterfalls of the same character are to be found, notably those intercepting the feeders of the Ribeira Grande, a stream falling into the sea on the northern coast. The Volta and the Santa Maria, on the southern slope, are similarly broken by cliffs as they fall from the plateau to the bay.

The stagnant waters on the surface, a notable cause of unhealthiness, are to be found in different zones of the island, owing more to the lie of the land than to the degree of precipitation, which is everywhere great.

In the northern zone, before any sanitary work was undertaken, swamps prevailed in the valleys, in depressions of the ground, and were screened by the forests, which not only concealed them, but interfered with their due evaporation in the dry weather.

In the central zone, marshes bordered the chief rivers, converting

Fig. 7.—Ribeira Anselmo de Andrade, on the Roça Infante D. Henrique.

the valleys through which they ran into swamps, especially where their flow was sluggish; in other places water would collect wherever there was a fold in the ground or a cavity without a proper outlet. The clayey nature of the soil allows of this accumulation of surface water for the greater part of the year.

In the extreme south, the ruggedness of the region, with its abrupt declivities and changes of level, has never favoured the stagnation of the surface water, though the rainfall there is always heavy.

All round the island on the littoral belt, on the courses of the mountain-torrents and the channels taken by the flood-waters from the hillsides, and where the tides invade it, there are numerous mixed swamps, often having intermittent communication with the ocean.

Geology of the Islands.—The soil of Principe, as of the other island of the Gulf of Guinea adjacent to it, is volcanic in origin; all these outcrops of land emerging from the ocean, perhaps fragments of one and the same portion of terra firma linked up in ancient days with the African continent, possess a close affinity of structure, of climate, and of fauna and flora, with the neighbouring colony of Kamerun.

Recently Auguste Chevalier, when studying the mineralogy of San Thomé, found materials for a conjecture that all the islands and archipelagos fringing the African coast from the Canaries down to St. Helena, not excluding the Azores, had a common origin, notwithstanding that up to quite recently the accepted theory was that the latter archipelago, with Madeira, the Canaries, and St. Helena, were vestiges of an anciently-existing continent unconnected with Africa proper. The fundamental reason for Chevalier's hypothesis lies in the presence of rocks of a special category—phonolithic felspars—in all the islands, these rocks being also known as constituents of the soil of Kamerun.

Throughout the island the basalts prevail, emerging in great masses on the tops of the highest elevations, many of the peaks which diversify its surface being composed of this rock, and their pinnacles nothing but gigantic blocks of basalt.

According to expert authority (Ernesto de Vasconcellos and Auguste Chevalier), the list of the volcanic rocks to be found in San Thomé and Principe is as follows: Trachytes, phonolites, dolorites, basalts, lavas, and volcanic ashes.

In the south-west region of Principe, and less frequently in other parts, the soil seems strewn with enormous basaltic blocks, formed in columns hexagonal in section, and piled up in a veritable chaos; the

Fig. 8.—Ribeira Mendes da Silva, in the Same Property.

commoner basaltic emergences are composed of more or less irregular masses not displaying the same structure.

In the lateritic lands of the plateaux and the tops of their spurs there is found a porous rock much sought after for building purposes, identified in Lisbon by Dr. Jacintho Pedro Gomes, through Professor Silva Telles, as limonite; at these places the layer of disintegration is of small depth, and the lands, poor for agricultural purposes, are locally known as *Budo-Judeu*.

Flora.—Taking 90 square kilometres as the area occupied by plantations and the dependencies of the agricultural estates, the present waste lands of the island should be 40 square kilometres, for the most part broken and mountainous. Of these, more than 30 kilometres, up to the fellings effected of late years by the official brigade and by the owners for improving the health of the island, were covered by forest.

The virgin forests of the island, known as *obós*, conformed to the type of tropical forests in regions of heavy rainfall, and were composed of species of great height and evergreen foliage. From the north to the south of the island the aspect of the forests and the characteristics of their contents varied but little; the trees were in general of useful dimensions, at times gigantic, ramification abundant and leafy, roots spreading superficially, aerial in certain species, in others buttressed at the base of the trunk. Lianas and climbing plants rose from the ground and hung from the branches of the arboreal species; while the undergrowth of the *obó* presented the general characteristics of scrub jungle.

Much of the northern plateau used up to recent years to be covered with this dense and all-pervading forest, in spite of the comparative poverty and thinness of the lateritic surface soil. In the dips and folds of the ground, where there was more humus and a greater humidity, tree-growth attained a fair bulk and more useful proportions, its general aspect being more vigorous. Thus, the whole of the flooded basin containing the feeders of the Ribeira Dunú, the Ribeiras Lama, Gallinha, and Tronco, was, so to speak, hidden under a canopy of dense foliage.

Mixed up with the more leafy growths, these woods also contained palms of the species *dem-dem* (*Elœis guineensis*), this being most frequent in the damper lands and below 250 metres of elevation.

Virgin forests used also to extend over the central part of the island, covering the hills and peaks of the Papagaio system, and the low-lying lands on the banks of the stream of that name. All the

Fig. 9.—Waterfall on Ribeira Bacharel, on Roça Porto Real.

broken ground in the south of the island, the steep flanks of its great *massif* of mountain, were, and still are, clad in forest, up to that part of the coast lying between the Ribeiras Porco and Antonio Franco.

Though the trees they contained were mostly of less bulky growth, the forests of the plateaux and of the more exposed hilltops were not on this account any the more accessible, for the multiplicity of slender stems, bushes, and creepers made its covering of vegetation just as impenetrable.

After it was cleared—a work undertaken in earlier times in order to prepare the land for cultivation, and more recently for reasons of hygiene—the usual result followed; woody species gave way to bushy and herbaceous growths. The character of this secondary vegetation showed considerable variety, in obedience to causes imperfectly studied, but in which the nature of the soil itself must have played an important part.

A point which at once became apparent in the sequence of spontaneous vegetation was this: in no case did the graminaceæ develop to the extent of covering vast tracts of country, as on the African continent; the *savanna* is a form of vegetation unknown in this island.

The first growth, following the operation of felling and clearing, is almost invariably bushy; but in a very short time, if the soil is not of too poor a quality, creepers begin to start up, climbing the trees which may still be standing, or scrambling over the stems of those that have fallen; they fasten their tendrils round every spur or stump they can seize, or they twine round one another. In the end they form regular galleries and vaults of verdure impenetrable to the rays of the sun, and through which it is difficult to make one's way; this disposition, typical of these regions, is locally known as *capoeirão*.

The other varieties of trailing vegetation in clearings are, for example, the begonias; the ferns—various species with large coriaceous leaves; and a graminea with long lanceolate blades, growing in clumps or tufts, known popularly as *ogá-ogá* grass. This last is a very quick-growing plant, and can easily cover a wide extent of ground and create a thick, entangling forest.

The cacao-tree is of small dimensions, rarely reaching 10 metres in height, and with a maximum diameter of crown of 6 metres. It attains its greatest leafiness in the last months of the rainy season, when the more vigorous plantations assume the aspect of veritable woodlands with very little undergrowth. In the dry season the *gravana*

Fig. 10.—Waterfall on Ribeira Grande do Sundy, Roça Sundy.

wind withers off most of its foliage, so stripping the tree that in the more exposed situations it presents a pitiable aspect.

In the older plantations the number of tall trees of the spontaneous island flora, retained as nurses for the cacao-tree (for the latter exacts a certain degree of constant warmth and damp, and is very sensitive to wind), was so great that many of them had relapsed into primitive forest. Of late years this had to be rectified by repeated clearing, screens of the thicker woodland alone being retained for the protection of the higher and more exposed lands.

Open plantations and cacao-trees without much foliage are liable to invasion of secondary jungle and noxious vegetation if not systematically cleared, a matter which has to be attended to as a rule twice a year. Some of the native plantations, badly tended, have degenerated into regular forest.

The island abounds in fruit-trees, such as the banana, the *andim* or *dem-dem* (oil-palm of Guinea), the coco-nut palm, the *mamoeiro* (*Carica papaya*), the avocado pear (*Persea gratissima*), the breadfruit-tree (*Artocarpus incisa*), etc. Excellent timber trees are likewise found in its forests.

The exports of cacao in 1900 were 1.700 tons; in 1911, 1912, and 1913, they rose to 2,363, 2,531, and 3,090 tons respectively.

In the earlier days of its colonization, sugar-cane was extensively worked on the island, but now the Roça Infante D. Henrique alone maintains a small plantation of this produce for its domestic requirements. Coffee has also now been abandoned, the quantity exported in 1913 being only 2 tons. Almost all the oil extracted from the *andim* palm is consumed locally; in 1913 the exports of palm-kernels was 37 tons.

Fauna.—Under this head the larger mammals would have been of special interest to us had any animal of this class been indigenous; but the members of the pig tribe which until recently ran wild in the island were merely descendants of domestic animals brought here at different periods. Their number had risen to about 5.000. The quadrumana are represented by a single species of Cercopithecus, of small size—*Cercopithecus mona* (Schreb.).

After the monkeys, living mostly in the forests, but damaging the cacao plantations badly, the commonest mammal in the island is a kind of civet-cat known by the name of *lagaia : Viverra civeta* (Schreb.). The habits of this animal are nocturnal, and it is both carnivorous and

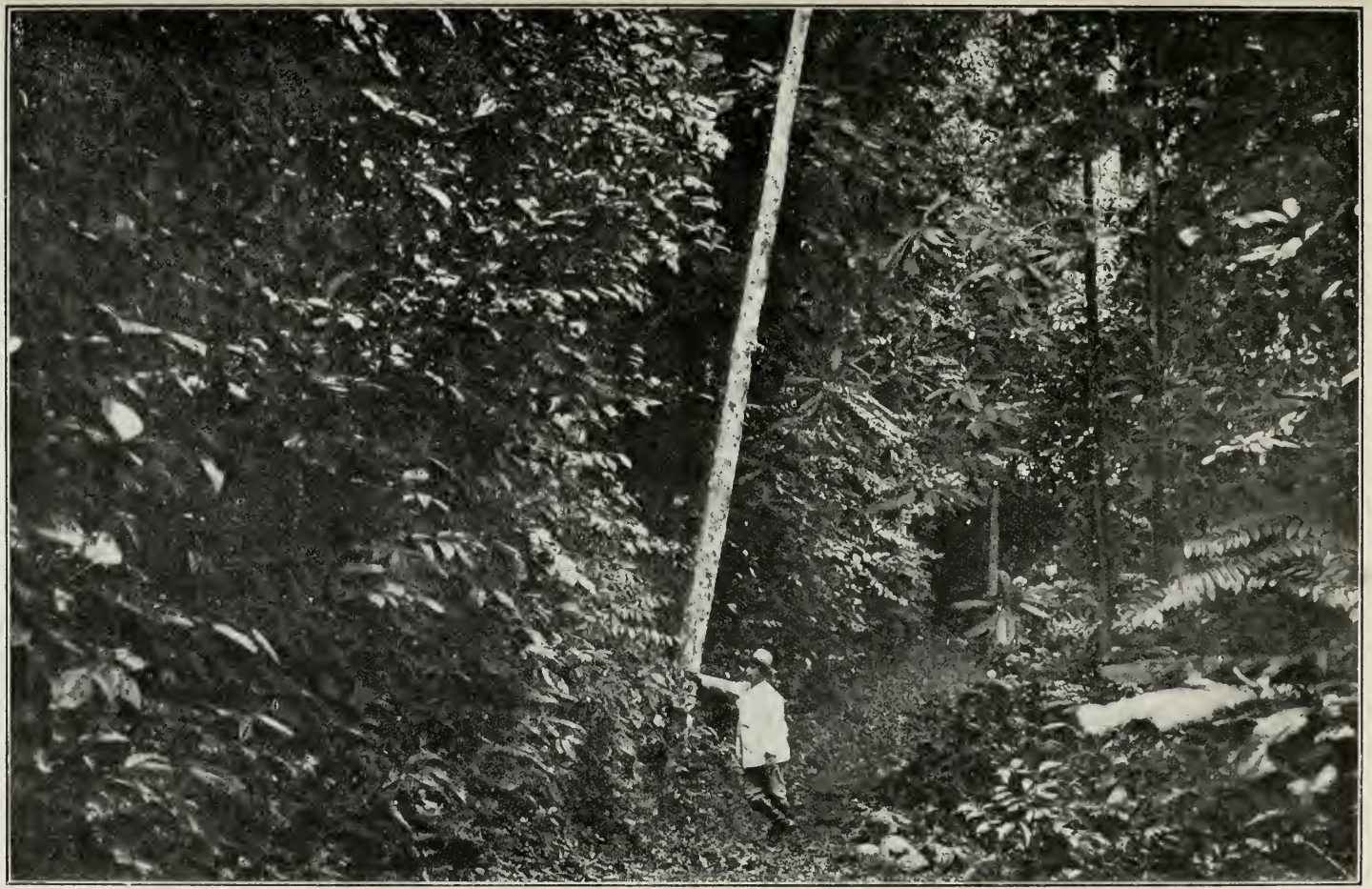


Fig. 11.—Virgin Forest, or Typical Obó, Roça Porto Real.

frugivorous; while engaged in hunting down the minor reptiles, birds, and rats, it finds time to pick off various fruits of which it is fond, such as palm-kernels, bananas, papayas, and avocado pears. It has been successfully reared in captivity on an exclusive diet of fruit.

An account of the mammals of the island would be incomplete without mention of the field-rats—a veritable plague to the planter—the domestic mice, and the frugivorous and insectivorous bats.

According to E. de Vasconcellos, many species of reptiles, batrachians, molluscs, and birds found in San Thomé and Principe, are peculiar to the islands; others are common to them and to the neighbouring continent. Certain curious differences between the fauna of San Thomé and of Principe are traditional; in the latter island, for example, parrots are abundant, but are unknown in San Thomé, while the parakeets abundant in San Thomé do not exist in Principe. There is also a venomous snake in San Thomé, said to be a variety of the surucúcú of Brazil, which is unknown in Principe.

Population.—In considering the population of this island, we have two elements to take into account—the native and the foreign, or fluctuating. The former is the less numerous, but is composed of two distinct sections: the natives descended from the first colonists of the island, known as *forros* or *filhos da terra* (sons of the soil), and the *tongas*, or children born on the island to the serviçal population. In the floating part of the population are included the Europeans, the Angolan natives, the immigrants from Cape Verde and Guinea, and some Orientals. Of these the first three races predominate.

The island began to be peopled in 1495, twenty-two years after its discovery, the grantees of lands using for this purpose, as was the custom in those days, the slaves acquired for them on the neighbouring African coast, apparently in Dahomey, Ajudá, the Congo, and elsewhere. In the last quarter of the eighteenth century the chief market for slaves for the island, which in its turn supplied servile labour for the *fazendas* of Brazil, was the Gaboon coast, not far off, navigation being easy, as the currents setting between Principe and that part of the continent were very constant.

The principal ethnical origin of the island natives would thus be the peoples of the Gaboon, to-day part of the French Congo. These in the course of time would become crossed with natives of Angola and sometimes with Europeans, but these intermixtures had but little influence upon the fundamental characteristics of that population.

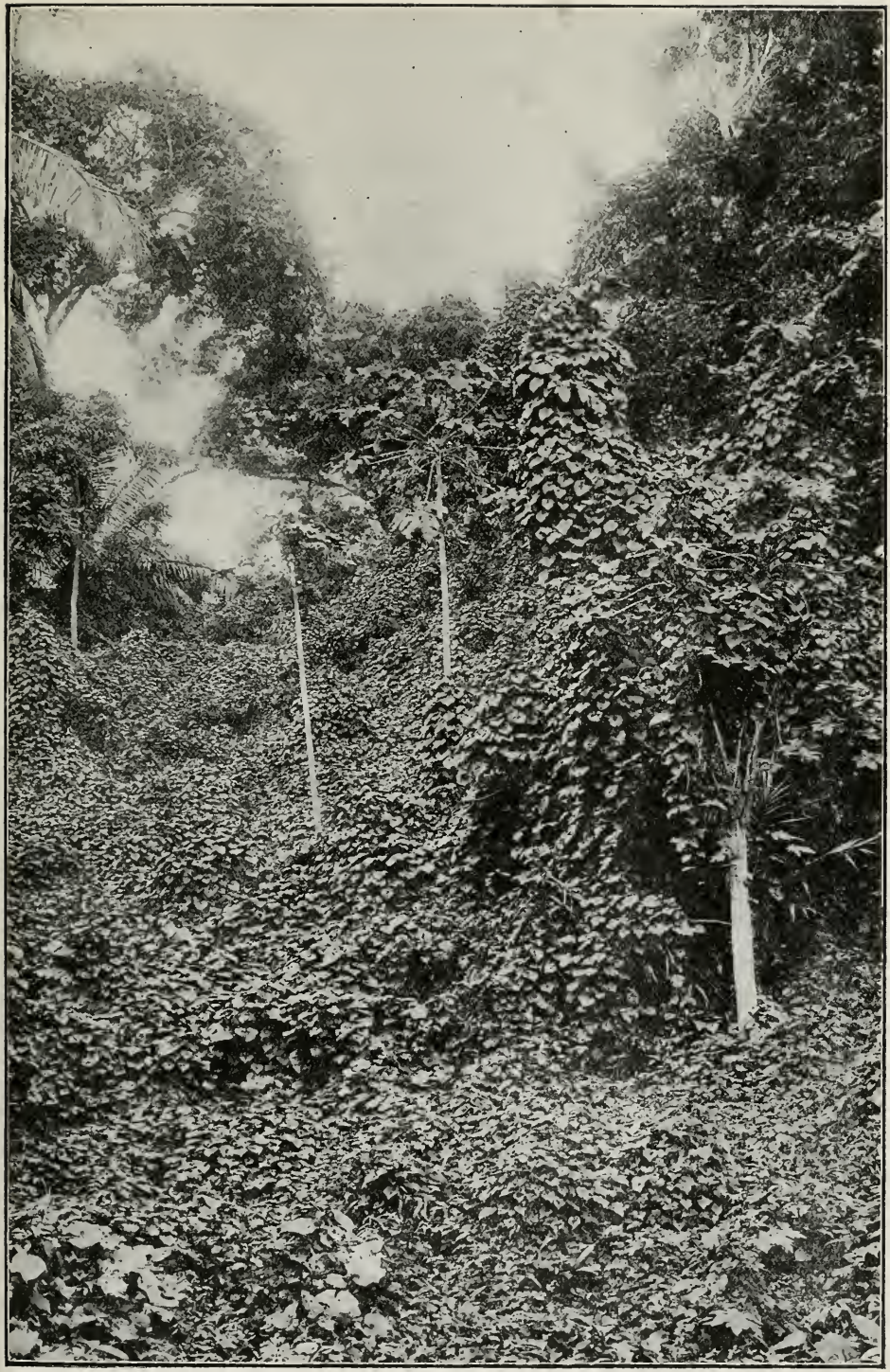


Fig. 12.—Typical Capoeirão, or Secondary Jungle, Roça Abbade.

Numerous up to 1885, in the years which followed they began to feel the disastrous effects of sleeping sickness, and by 1908 their numbers had fallen to under one-tenth the total population of the island; in late years, however, the native population is showing signs of renewing itself.

The native of Principe makes it a point to live a life quite apart from that of the rest of the community, both African and European. He retains habits, traditions, and festivals of his own; he has all along resented attempts by the old Portuguese to assimilate him, and resists the influence of the missionaries and religious Orders. The dialects spoken in San Thomé and in Principe differ slightly one from the other, but both are corrupt forms of the Portuguese language. The people are intensely religious, but mix up the Christian liturgy with practices derived from fetishism.

The islanders proper are pacific in disposition, sedentary in habits, temperamentally averse from hard work, and very improvident. In olden days they owned valuable properties, but are now almost entirely ruined through borrowing money upon them at usurious rates, so as to devote themselves to the enjoyment of the continual festivals in which they pass their time. European agriculture does not recruit a single hand from among them; their only ambition is for office work.

The tongas, as we have said, are descendants of the serviçaes, and are born in the island. The last census reveals the existence of 604 individuals of this class, of whom a little more than the fifth part are adults over sixteen years of age. In bygone days proprietors used to promote marriages between their Angolan serviçaes, male and female, giving them certain tangible encouragements to induce them to establish themselves in the island. The support and education of the children were the employer's special charge, and in some *roças* there are still crèches in regular working order. When the children came to years of maturity, they had acquired industrious habits, and continued to live on the estates where they had been born, marrying there and serving their parents' employers under a régime of free labour. It was unusual for them to enter the category of *forro* or *filho da terra*.

As the number of Angolan serviçaes employed on the estates has fallen considerably, and minor children are being repatriated along with the families of which they form part, there is a corresponding

Fig. 13.—Group of Negro Labourers.

decrease in the number of *tongas*. But some of them, having been left orphans, must perforce settle definitely in the island.

Of the European population, almost two-thirds live on the estates, engaged in agriculture and employments subsidiary thereto. In May, 1914, the European population of the town was only 79, while that of the estates, including the official brigade, was 120 souls.

The most important section of the community is the contracted labourers, whose maximum stay in the island, except in the case of re-engagement, is three years. The natives of the Cabo Verde Islands as a rule elect to contract themselves for two years at a time.

In the first days of cacao cultivation, emigrants from Ajudá were introduced as workers; also, it appears, from Liberia and Acrá. But up to 1903 almost all the agricultural labourers were recruited in Angola on five-year contracts, with option of renewal. Some of these, having raised up families, ended by settling in the island, taking advantage of certain concessions made to them for that purpose. On some estates it was the practice to grant the older serviçaes plots of land, the fruits of which, cultivated by themselves, they had the right to use as their own. This was the rule, for instance, on the Roça Sundy, up to 1893. It is to be regretted that, on the one hand, the rapacious tendencies and the inherent indolence of the African, combined with the rage for utilizing all available land, on the other, should have injured the prospects of success of this measure. It was a system infinitely preferable to *sanzala* (barrack-room) life; but the failure to fix the Angolan native has been due quite as much to considerations of health as to his inability to reproduce here the family life of his own social environment—to make his home in the island.

As far as we can gather, in 1908 the number of Caboverdean serviçaes on the island was less than 150; after that year, and proportionately to the progressive reduction in the numbers of the Angolans, the former increased until their figure exceeded that of the others by one-third (2,120 Caboverdeans to 1,529 Angolans).

The emigrant from Cabo Verde shows no great inclination to settle in the island, whither he only comes for the sake of what he can earn. Natives of San Thiago, although more susceptible to malarial influences than natives of Angola, generally manage to resist the climate of Principe; but, on the other hand, immigration from Santo Antão, recently tried, has given disastrous results.

We give below a statistical table, somewhat fragmentary, of the

population of the island during recent years, but we must observe that some of the figures it contains are merely approximate.*

Table II.—Statistical Summary of the Population of Principe in Recent Years.

Years.	*Floating Population*					*Fixed Population.*			*Total Population.*
	Europeans.	Cabo-verdeans.	Angolans.	Various.	Total.	Islanders.	Tongas.	Total.	
1885	—	—	—	—	—	3,000	—	—	—
1900	—	—	—	—	—	800	—	—	4,747
1908	150	134	3,196	—	3,480	350	—	—	3,830
1909	—	—	—	—	—	—	—	—	3,488
1910	—	—	—	—	—	—	—	—	3,663
1911	160	634	2,593	28	3,415	400	—	—	3,815
1913	169	1,409	2,029	—	3,607	550	781	1,331	4,938
1914	199	2,120	1,529	142	3,990	668	604	1,272	5,262

Climatology.—Besides features due to its insular character, the climate of Principe displays those of equatorial climates in general, as may be guessed from its geographical situation.

In the northern and central zones of the island the temperature of the air up to an elevation of 150 metres shows but little variation throughout the year. The mean annual temperature is about 25·4° C., a variation of about 2° C. being observed between the mean of the rainy season, which is the hotter, and the dry or cooler season. The slender data which we have been able to collect give us a mean temperature of 26·4° C. for the former, from October to May, and of 24·3° C. for the latter season, from June to September.

The extreme oscillations between the different months of the year

* According to the authoritative opinion of the engineer Ezequiel de Campos, the natives of San Thomé and Principe draw a distinction between *forros* and *filhos da terra*, the former expression, notwithstanding its general use, being regarded as insulting. *Filhos da terra* seems to denote the aristocracy of the islands, a mixed race due to the crossing in very variable degrees of the Gaboon native and the European—*i.e.*, of people who have never lived in slavery. *Forros*, on the other hand, means the free descendants of slaves, and includes Gaboons, Angolans, and other native races.

The term *tonga* is used by us here in its current acceptation, that being official; but, according to Sr. Campos, its true meaning is to a certain extent different; it should be applied, properly speaking, to the hybrid between the serviçal working under a contract on an estate and the already naturalized native.

have for their approximate limits the temperatures of 24° and 27° C., and the daily range is rarely greater than 7·5° C., varying as a rule between 2° and 6·5° C. upon the temperatures recorded between 6 a.m. and 6 p.m., corresponding to a daily variation of 4° C.

During the whole year the thermometer rarely falls to 20·5° C.—the lowest figure recorded during the last two years—and only exceptionally does it rise above 32° C. During the twenty-four hours of the day it ranges between 25° and 28° C., and on rainy days its maximum does not exceed 26° C.

In the south of the island, in consequence of the special factors prevailing, the fall of temperature corresponding to the dry season is more accentuated than in the rest of the island, the annual mean showing likewise an appreciable depression; thus the mean figures of the two principal seasons there are, approximately, 24·8° and 22·5° C., and the annual mean does not exceed 23·8° C. According to the data for the last three years, for which we are indebted to the Management of the Roça Infante D. Henrique, the absolute daily maxima of this period were 29° C. and the minima 20° C. At the height of the dry season, in August, the temperature in the shade at 12 noon does not as a rule exceed 24° C. The daily ranges of temperature are almost always less than 2° C., and the maxima corresponding to the two last months of the rainy season were, in the same period, 4° C.

No figures are forthcoming as to the degree of humidity prevailing in the island; its absolute value must necessarily be high when we consider the very small area of terra firma in regard to the great mass of water surrounding it, and the position of the island in the equatorial zone of great evaporation. Relative humidity in the rainy season must be very close to saturation point, in virtue of the vast precipitation which then takes place, of the action of the winds from the south, constantly launching masses of vapour upon the island, and of the lavish vegetation of the soil.

Absolute data are also wanting as regards the annual pluviometrical figure, considered higher than that of San Thomé; and also as regards barometrical oscillations. The former reaches its maximum in the south of the island, where it cannot be far off 3,000 m./mm., and 2,000 m./mm. in the other zones. According to the data registered by the Sociedade de Agricultura Colonial, the number of days of heavy rain in 1913, in the centre of the island, were 79, and of light rain 29; in the Roça Infante D. Henrique, the mean during the

years 1911 and 1912 was 77 days of heavy rain and 90 days of intermittent.

In the island two distinct seasons are to be observed—that of the rains, between October and May, with a hypothetical interruption between January and February (*gravanito*), and the dry season, or *gravana*, from June to September.

During the former the winds blow with slight interruption from the south and south-west, carrying with them great clouds which condense in copious showers. From January to March violent thunderstorms occur, brought up by gales of wind, transient but nevertheless furious, from the north and north-east. These storms are probably the aftermath of the terrible cyclones or tornadoes which devastate the basin of the Niger about the same period of the year.

In the *gravana* the direction of the prevailing wind is between south and south-west, but it is a dry one, blowing with much violence but intermittently. It makes itself felt for the most part in the afternoons, between 2 and 5 p.m., and has a great power of absorbing moisture. During this season the sky is almost always clouded, the higher peaks being immersed in layers of cloud, but the rains are scanty, and in some years they fail altogether for months at a time. But the period of suspension of the rains is quite uncertain in its duration; in 1913, for instance, there was still some rain for several days in June, the month of July was entirely dry, and from August onwards the rains never ceased; it was a year almost without a *gravana*. In the current year, on the contrary, the *gravana* has been severe, for in the north and the centre of the island it did not rain once between May 5 and August 12. A drought so prolonged, with winds that draw every drop of moisture from the soil, accompanied by an exaggerated depression of temperature, causes serious damage to the plantations, not only spoiling a great part of the fruits in process of formation, but also killing off a large number of trees. Years of persistent *gravana* spell utter ruin to local agriculture. At times there may fall a few drops of rain so fine that they scarcely moisten the soil, a phenomenon known in San Thomé by the name of *leite voador* (" the milk of the flying-fish " —an allusion to the milky spray which the flying-fish drops from its body as it rises from the surface of the sea in flight).

The factors regulating the chief characteristics of the island climate are easily appreciated.

From October to May the island is almost constantly within the

ambit of the great ring of equatorial evaporation, or zone of cloud rings (*pot au noir*); this is the period of torrential rains.

The absence of a short dry season of well-marked character, usual in equatorial regions lying slightly to the south of the thermic equator (5° N. Lat.) is due to its being too far to the south of the latter and at the same time too near to the geographical equator (1° 35′ N. Lat.); the width of the nebulous ring being 5° approximately, and the limit of its meridional excursion the parallel of 2° S. Lat., it results, theoretically at least, that the island is never outside the influence of solar aspiration when the sun, travelling southwards, reaches the tropic of Capricorn.

From June to September, the sun, travelling northwards, carries with it a zone of low pressures, which in July is to be found, approximately, between 5° and 10° N. Lat., and only then is the island outside of its influence. Hence the dry season.

The prevailing winds of the rainy quarter undoubtedly depend on the aspiration exerted by the neighbouring continent which folds the island in the semicircle of the Gulf of Guinea, at a distance of from 200 or 400 kilometres. In the Gulf there is then a zone of low pressures determined by solar incidence on the great continental mass, in which the mountains of Kamerun bulk largely.

In the *gravana* the island is swept by the southern trade-winds, deflected somewhat from their course by continental land influence. Notwithstanding their long passage across the watery area of the southern hemisphere, they are perceptibly dry winds.

The only marine current which seems to our mind likely to have an influence on the climate of the island is a branch of the equatorial counter-current, flowing in a west-to-east direction, slightly inclined towards the south, along the northern coast of the Gulf of Guinea, and thus hastening the speed of the steamers making for Principe from the north with effect from their passing Sierra Leone. Its existence is further demonstrated by the fact that canoes of fugitives from the island and boats that may have broken loose from their moorings constantly drift over to Fernando Pó or to the Kamerun coast, including Spanish Guinea. The climatic action of this branch of the great equatorial current can only be the enhancement of the evaporation phenomena peculiar to the zone in which the island lies, with, however, only a slight effect upon the atmospheric movements taking place there.

The principal climatic differences which, in so restricted an area, evince themselves between the southern zone and the remainder of the island, result for the most part from the superficial configuration of the land, its orographic masses being crowded together in the south, where they establish a kind of barrier to the dominant atmospheric displacements. Over that zone thick clouds continually hover, piled up by the winds from the high seas when these collide with the southern slopes of the peak district. These clouds dissolve in copious showers as they rise to the hill-tops on their way northward. The same reason explains the thermic differences already noted, converting the southern zone of the island, in the dry season, into a region with a temperate climate.

Similar climatic variations take place in other parts of the island, all being subordinated to its form and to the lie of its elevations.

Even in the southern zone the thermic differences between the slopes which face to the south and south-west, and those which face to the south-east, are quite perceptible; so much so that the flowering and fruiting of the cacao-tree in the lands of the Roça Infante D. Henrique, for instance, are sadly handicapped by the gales and the thermic falls of the *gravana* season, while in the Neves Ferreira section of the same property, the valleys of which look to the south-east, cacao-growing is carried out with complete success.

On comparing what happens on the northern with what happens on the southern aspect of the Peak *massif*, we find similar differences; as soon as one doubles the point of the Pico das Duas Cabeças, in coasting the island from the south, and arrives off the Ribeira Fria, one finds oneself at once in a more temperate atmosphere, the line of mountain-tops running up from west to east being sufficient to offer a defence against the severity of the *gravana*.

A little farther on, in the Roça Terreiro Velho, the cacao plantations climb the steep slopes looking to the north and east, up to and over 300 metres of elevation, in good conditions of vegetation.

In the rest of the island the climate presents a constantly greater regularity in the deep narrow valleys furrowing its seaboard slopes, so long as these do not open towards the south, than on the plateaux or on the ridges of the spurs and underfeatures. In those the stagnation of the air, the less sunlight, the greater heating capacity of their humous soil, realize the conditions of a suave and humid climate ideal

in its conditions for the cultivation of the cacao-tree; the depressions of surface known as "grottoes" are a perfect agricultural medium. The plateaux and the crests of the spurs (*cavalêtes*), swept as they are by the south winds, present a climate relatively harsh and unkindly, especially during the *gravana*. The atmosphere is then less humid, and the soil, unwashed by the rains, becomes less capable of fixing heat and moisture. The clearing of the forests that used to cover the northern plateau of the island, a work demanded in the interests of its sanitation, has to a certain extent increased these climatic defects, but it cannot be said to have reduced its agricultural value, that region never having had any worth mentioning.

The Glossina Palpalis—its Distribution and Life Conditions in the Island.

The presence of the *Glossina palpalis* in Principe must be ascribed, so it appears, to a case of importation. According to tradition, this took place in the beginning of last century, at a time when the slave trade and the cattle trade kept alive a frequent movement of shipping between the island and different points on the coast of the Gulf of Guinea, especially the Gaboon.

As is well known, outside the African continent there only exist the focus of *G. tachinoides* on the Arabian coast and the two foci of *G. palpalis* on the islands of the Gulf of Guinea, one in Fernando Pó, the other in Principe. Thus it appears that the possibility of dissemination of the insect by sea under ordinary circumstances is pretty limited, and the case of Principe, the minimum distance from which to the African seaboard is 200 kilometres, has only the value of an exception; the invasion of Fernando Pó, whose distance from the coast is only 40 kilometres, was certainly a much easier matter than that of Principe.

Yet the island of San Thomé, 290 kilometres from the coast and only 130 kilometres from Principe, and presenting for the development of the insect conditions entirely similar to those of the two infected islands, and in constant trade relations with them, has been able to keep itself free from infestation up to now. The voyage from Principe to San Thomé, in steamers of the regular line, is only one of ten hours; the boats anchor in Principe at from 200 to 300 metres from the shore, and often carry, when southward-bound, live animals which might readily attract the insect to them; and glossinas have often been noted

Fig. 11.—Capoeirão before clearing: Roça Sundy, near Ribeira Lama.

on the small boats putting out from the jetties to meet the mail-boats, and have even gone all the way to the latter. Still, in spite of a combination of circumstances seemingly favourable to the propagation of the insect from one island to the other, such a case, happily, has never occurred.

The navigation of the great watercourses of the African continent offers no such guarantees. The margins of these are overshadowed by equatorial forest; and in 1910 the Belgian scientific mission observed that when going upstream the *G. palpalis* could be carried by steamers navigating the Congo for 140 kilometres—a journey corresponding, in point of time, to one of 280 kilometres downstream.

The original landing-place of the glossina in Principe, coming from the opposite coast, is supposed to have been the beach of Ribeira Izé, on the northern coast of the island, where the little vessels in use at that time used to ground; thence the infection must have spread to the rest of the island.

And, in fact, it was in the northern part of the island that the epidemic flourished with the greatest intensity, and where the largest tribute to death through sleeping sickness was paid. But it must be borne in mind that in this zone certain well-marked topographical conditions existed, to a great extent explaining the form in which the distribution of the insect took place.

In recent times, but before work in the direction of sanitary improvements had been carried out on any large scale, it may be said that the *G. palpalis* was ubiquitous throughout the island with the exception of the southern part. In the history of the epidemic in the island, the places where the chrysalis of the insect was deposited were unknown, as search for them could not be made at the right time. But meanwhile its principal breeding-grounds and the places where it used to have a permanent abode have become well known.

The conditions characteristic of these foci or lairs of the glossina in the island were mainly as follows: More or less damp places, sheltered from winds, on the banks of streams, rivulets, or swamps, covered with dense vegetation, either in the form of shady forest (*obó*) or clumps of herbaceous plants in which creepers almost always predominated (*capoeirão*), corresponding in a general way to the haunts of the wild pigs; they were never to be found higher than 250 metres above sea-level.

In the whole of the northern and central parts of the island the

Fig. 15.—A Former Focus of Glossinas in the S. Jeronymo Region, Roça Sundy

Note the trees ringed by burning.

places suitable for glossina life were so abundant that it was difficult to say where they were likely to meet with any conditions hostile to their existence; however, we may meanwhile admit the presence of four categories of foci, with varying prevalence in the three zones into which we will regard the island as divided.

First Category : Foci of the Slopes of the Plateaux.—These occur for the most part in the deep narrow valleys, with abundant vegetation and running water, which furrow the broken stretch of land lying between the edge of the plateaux and the coast-line, and follow a course east and west, inclined to the north; when they are inclined towards the south, atmospheric conditions make it difficult for glossinas to live.

On the sides of these valleys, although they are everywhere almost exclusively devoted to the intensive cultivation of the cacao-tree, a considerable growth of leafy trees representing various forest species is retained, being deemed indispensable by the local agriculturist for shading his plantations; the brooks running down these *thalwegs* often pass under veritable tunnels of the most varied kinds of plant-growth, intermixed with dead trunks of felled trees, the removal and clearing of which is rarely attempted.

These foci play an important part in the history of the epidemic of this disease in the island, cropping up as they do all through the important plantations in places frequented by the labouring establishments. They have to their debit a large number of inoculations, and have contributed vastly to the unhealthiness of the northern zone of the island.

To be included in this category are the numerous patches of glossina-cover in the north and west of the Sundy estate, and in the narrow passes opening from north-east to north-west, cracks, as it were, in the whole northern littoral from the Roça Bombom down to the Roça Campainha, a range of 6 kilometres. The estates most afflicted through this class of foci, besides Sundy, were the Roças of Santa Rita, Pau Fita, Cascalheira, and Aguiem; in 1911, for instance, not a single serviçal of the Roça Cascalheira had escaped the infection.

The lands on the southern shore of the bay, between the Ribeira Fôrca and Praia Baleia, occupied up to quite recently by small native proprietors, were a similar focus of infection. Other small foci of the same character were to be found on the southern slope of the plateau Montalvão-Ponta do Sol, as, for instance, that of the Ribeira Volta, of the basin of the Ribeira dos Frades, and of the Rio Bacharel.

Fig. 16.—Large Capoeirão near Cornelio Beach on Roça Sundy, one of the Last Places where Glossinas were found

Fig. 17.—Banks of Manoel Lima Stream before clearing: Roça Sundy

Second Category : Foci of the Plateaux.—The great forest area occupying the centre of the northern plateau of the island was also the headquarters of a big swarm of glossinas; in it they found, within the virgin forest, a still air, a uniformly even temperature, the sun's rays merely filtering through the leafiest of foliage, this protecting by its shade vast extensions of morass and swamp; in a word, all the comforts of a permanent home for insect-life.

A great part of the Roça Praia Inhame, the Roça Azeitona, Teracía, the *dependencias* of Oqué Gaspar, Ponta do Sol, Oqué Caça, and Boa Entrada, belonging to the Roça Sundy, lay within the ambit of this focus.

Of the other plateaux of the island, the valley of San Joaquim, in which lay a wide, flat forest region, was also the site of an important insect focus, whose noxious influence made itself severely felt among the workers of the western part of the great property of Porto Real; in the *assentada* of Nova Estrella, almost entirely under cultivation, only one dip in the ground, in the basin of the Ribeira Fôrca (Damião) was affected by it.

Third Category : Marginal River Foci.—The marginal lands of certain rivers in the island, more or less flooded, shaded by high forest growth, were also favourite breeding-places for the glossina, the foci of which fringed the waterways of the island all over its extent.

These marginal zones mostly abounded in the central part of the island, where the larger watercourses are to be found with the greatest length through low-lying lands; the chief of these zones was in the basin of the Papagaio, and covered the lower two-thirds of its main stream, infesting also the banks of its affluents, notably the brooks Marmelo and Bomjardim on the left bank, and the Ribeira Fôrca on the right, near its mouth. All the eastern part of the Roça Porto Real was under the influence of this focus of infection, also the Roças of Terreiro Velho and Bella Vista, as well as the town of Santo Antonio; the rivers Banzú and Bacharel, also the Ribeira dos Frades, the former in the western part of the island and the latter in the east, were similarly infected in the middle and lower portions of their course.

In the basin of the Ribeira Dumú-Izé, in the north of the island, which was literally invaded by the *tzetze*, being from its source to its mouth nothing but a colossal nursery of glossinas, conditions were of a mixed type—a swampy highland focus in the extensive wide marshes of its head-waters and part of its upper course, and a riverside focus

Fig 18.—Mixed Swamp of Praia Grande, a Former Hotbed of the Fly, now cleared, adjoining Roça Paciencia.

Fig. 19.—Mixed Swamp of Praia Grande: Portion adjoining Roça Sant' Anna.

after it enters the valley of Ribeira Izé. The first-mentioned of these is contained within the great central affected area of the northern upland, and the second is its continuation down to the coast.

Around the swamps of the Ribeiras Lama and Gallinha, the Roça Montalegre, the Pincaté section of the Roça Porto Real, and a great number of small properties, used to have their labour establishments constantly decimated; on either slope of the valley of the Ribeira Izé, the roça of the same name and the Oqué section of the Roça Sundy paid a similar tribute in lives to the devastating epidemic.

Fourth Category : Foci of the Mixed Swamps.—These swamps, more frequent in the north, are generally formed by the confluence of several small streams in the low lands of the coast; the accumulation of detritus brought down by the floods creates alluvial deposits, lagoons, at times visited by the tides, at others in communication with the sea.

The foci that used formerly to exist at the Praia das Burras on the Roça Paciencia belong to this group, and so do those of the swamp of Praia Grande, between Paciencia and Sant' Anna, of Praia Salgada on Roça Abbade, on the beach of Roça Santa Rita, and on that of Lapa on the west coast. On the edge of these swamps, close to high-water mark, on the bits of dry land rising out of the water, vegetation used to spring up in the form of clumps of bushes, under which the glossinas sought shelter, and started out to attack the labourers on the adjoining plantations or the boatmen in charge of the landing-stage and the lighters.

As regards their regional distribution, the foci of glossinas in the northern part of the island belonged to all the groups above indicated, but chiefly to Categories 1, 2, and 4. Clean areas were the exception, being only to be found on a few isolated hills in the north-eastern angle of the island (Ponta do Belmonte), on the southern slope of the peninsula of Abbade, and on part of the northern slope of the bay of Santo Antonio.

In the central part of the island, infestation limited itself chiefly to the lands and the hydrographical basin of the rivers, not as a rule going beyond 250 metres of elevation.

It seems always to have been impossible for the fly to establish itself in the southern part of the island; in 1911 a few glossinas made their appearance in the *dependencia* of Neves Ferreira on the Infante D. Henrique estate, but they very soon disappeared, a trivial cleaning-

FIG. 20.—MIXED SWAMP AT MOUTH OF SANTA RITA STREAM ON ROÇA OF SAME NAME, NOW RECLAIMED.

up of an unimportant swamp being sufficient for the purpose. From 1902 to 1906 this estate showed a comparatively high mortality from sleeping sickness, explicable either by a faulty diagnosis or by importations of serviçaes from infected areas in Angola; after medical attendance upon the labourers became more regular, the trouble did not again occur.

Besides topographical conditions, another factor in the distribution of the glossina in Principe has long been operative—the existence of a number of half-wild pigs, escapes from domestic stock, or set at liberty by their masters on account of their excessive reproductiveness. The number of pigs running wild in recent years throughout the northern and central portions of the island has been estimated at 5,000. These animals used to remain for long periods in the heart of the forest, or hide in the secondary jungle, feeding on the fallen fruit of the *Elœis guineensis* and the roots of manioc to be found in lands where formerly there had been native plantations. They would grub in the mud-holes, under the shade of the woods.

Thus, the favourite haunts of the pig coincided with those in which the *Glossina palpalis* found the most suitable conditions for its own proliferation; and, on the other hand, the glossinas, finding in the blood of those animals an abundant nutriment, took advantage of their passivity under aggression, and ended up by living in intimate association with the pachyderm, so that of late years the distribution of one and the other species has been approximately parallel.

This coincidence, verified by the Correia Mendes Mission in 1907, was clearly brought to light in the labours of that Mission; since when the facts have done nothing more than confirm it abundantly.

Looked at beside its relations with the habits of the pig, the problem of the life of the *G. palpalis* in the island presents itself to us in a somewhat different light, but one nevertheless interesting and fertile in deductions.

The absence of the glossina from the south of the island would thus explain itself by the absence of the wild pig from the same region. As a matter of fact, in the estates of the Companhia da Ilha do Principe these animals were always kept in their own sties, and access to the Company's lands, defended on the north by a barrier of mountains, was always closed to the wandering herds from other places. And further, up to the beginning of the present agricultural undertaking in 1894, there only existed impenetrable forests where natives of the

Fig. 21.—Out-Station (Santa Emilia) of Roça Terreiro Velho, once a Hotbed of Glossinas owing to Proximity to a Piggery.

island never had established themselves, and where, consequently, no domestic pigs could have been abandoned to run wild, as took place in the rest of the island.

The association between the diptera and the pachyderm would also give us the reason for the disappearance of the glossina from the more exposed points of the upland regions during the *gravana* season, for it was then that the pigs used to emigrate from the plateaux, where surface water began to get scarce, to the sheltered valleys, in search of drinking and wallowing pools; thither the glossinas followed them, and anyone looking for them would find them hidden there.

The disappearance of the glossina from places above 230 to 300 metres has likewise its relation to the habits of the pig, these being rare above the limits of the oil-palm (*andim*), of which the pig is fond for the sake of its fruit.

Thus, it is more natural that the distribution of the glossina should depend simultaneously upon the habits of its host, and upon the other factors enumerated; it is even probable that in the early history of the insect in the island, topographical conditions had the chief influence, and that only later on, when the increase in the numbers of swine assumed greater proportions, did the former prefer to settle in the places of refuge of the latter.

Up to 1910 there existed in the northern part of the island some wandering herds of cattle, or animals driven out to pasture in the enclosed areas (*ubas*) of the Roças Sundy and Belmonte; the number of these animals was never large, the prevailing epizootics not allowing of their multiplication on any considerable scale. It would appear that the number of head of cattle raised thus never exceeded 50.

Besides the swine and cattle living permanently in liberty, there used to be some hundreds of stray dogs—animals likewise much sought after by the glossina. Moreover, all the inhabitants of the island, and in particular those engaged in agricultural work, all the domestic mammals—horses, mules, sheep, and goats—offered abundant feeding to the deadly diptera.

Of the mammals indigenous to the island, the monkeys and the civet-cats, none contributed appreciably to the nourishment of the glossina; in repeated examinations of the blood of many individuals of these species, none was found to be a carrier of any kind of trypanosoma, although both animals are susceptible to the prevailing parasites of the island.

There are no crocodiles and no larger terrestrial lizards in the island; in various examinations of the stomach contents of glossinas we have never found nucleated globules of any kind, and it also appears probable that none of the various species of birds in the region counts for anything in the life of the insect.

Within the restricted area of the island, the glossina moves about frequently from place to place, either passively or in pursuit of men or animals. It was a matter of common observation that the arrival in the town of animals from the more infested estates coincided with the appearance of an appreciable number of flies in it, where as a rule they are rare.

In the south of the island, it often happened that they appeared concurrently with riders coming from the north, some having been even seen within the headquarters of the Roça Infante D. Henrique. But they never succeeded in establishing themselves there, notwithstanding the abundant aliment offered by the serviçaes and the stalled animals on the estate. The climatic conditions peculiar to that zone, it will be here seen, must have had a more important share in the exclusion of the insect from permanent residence than any other circumstance, not even the absence of swine in a state of liberty.

It is interesting to emphasize the peculiarity of the infestation of Principe by the *tzetze*—namely, the existence of foci of glossina down to sea-level; the fact becomes comprehensible when we take into account the character of the local vegetation, which breaks out with an extraordinary vigour from the high-water mark on the shores, and give the island that typical aspect so much admired by all who visit it for the first time, that of a colossal bouquet of greenery emerging direct from the ocean.

PART II

THE WAR AGAINST SLEEPING SICKNESS IN PRINCIPE— PLAN OF SANITARY CAMPAIGN, AND ITS EXECUTION

Legislative Provisions and their Application.

The Correia-Mendes Mission left Principe in September, 1908, and shortly afterwards presented to the Central Government the results of its labours, defining the basis on which measures destined to extinguish the epidemic should rest.

Nevertheless, up to the opening of the year 1911, no legal instrument authorized the sanitary authorities of the island to compel private individuals to carry out the measures prescribed, the struggle being limited to the use, at times disregarded, of atoxyl, and of gluey cloths worn on the backs of the serviçaes in some of the estates. It was then that the Government of the Province, over the signature of Governor Miranda Guedes, issued a notification enforcing the execution of nearly all the measures prescribed by the Correia Mendes Mission, making the landed proprietors responsible, subject to heavy fines for non-compliance, for the fulfilment of the obligations thus imposed upon them.

In this notification, dated February 11, 1911, it was made compulsory to clear the secondary jungle (*capoeirão*), to fell the forests; it was forbidden to breed pigs anywhere in the island, all existing animals of the species being exterminated wherever found; and suitable gauze wire netting was directed to be provided and fixed in all the dwellings of the staff and establishments, be these European or native. Draught animals, likewise, when not at work, were to be similarly protected in stalls made impenetrable to glossinas by means of gauze wire netting. To protect the serviçaes when engaged in field-work, light-coloured clothing was to be worn, covering the body down to the wrists and ankles, a cover of similar colour being worn on the head; in the places

most infested by the fly the houses were to be protected by a cleared margin of land all round of at least 100 metres radius; all persons stung by the fly were obliged to report themselves and receive a preventive injection of atoxyl within twenty-four hours of the occurrence; direct war was to be made upon the glossina by means of black cloths covered externally with a layer of viscus, these to be worn on the backs of the men and the animals alike, and to be fixed in the places where the insect most abounded. The defence of the island was to be completed by means of inspections of all serviçaes on entering and on leaving it, of isolation hospitals for those attacked, and of quarterly examinations of the blood of all the inhabitants and domestic animals.

The fines incurred by those contravening the provisions of this notification ranged from one to one thousand dollars (escudos).

Governor Miranda Guedes came personally to Principe, along with one of the doctors who had formed part of the Correia Mendes Mission, arriving February 22, 1911, in order to convince the planters of the advantages gained by obedience to the law, and for forty days all immigration into Principe was suspended, this interdict being only raised to allow of the importation of labourers to carry out the executive orders issued.

On March 16 of the same year, after the planters of Principe had been heard by the Governor, and the latter had been convinced of the necessity for making certain alterations in the original measure, a fresh notification was published, No. 125, clearing up certain provisions of the former, and endeavouring to render certain others more practicable. In the purely sanitary part of the measure, these alterations consisted in the adoption of covers for the nape of the neck attached to the head-covers to be worn by the male serviçaes, in the reduction to 10 per cent. of the number of serviçaes wearing sticky cloths in each relief of labourers, in the exclusion of cacao-trees properly treated from the category of noxious vegetation when adjacent to dwellings, and in the fixing of a maximum of seven hours from time of sting by the fly to time of administering the injection of atoxyl. Other provisions complementary to the executive order also found a place in this second notification.

Meanwhile there was lacking to these measures the confirmation of the Central Government, to allow of their producing their fullest effect through a rigorous and active working at the hands of the sanitary and administrative authorities. The first Decree of the Government

of the Republic, dated March 25, 1911, confined itself to the matter of mechanical defence for dwellings.

On April 17, 1911, the head of the department of health in the Ministry of the Colonies being Dr. Serrão de Azevedo, a second Decree was published by the Provisional Government, based on the recommendations of the Correia Mendes Mission, and giving the force of law to the chief provisions of the provincial notification of February of that year, with effect in the colony from May 20, 1911. The changes made by this Decree in the original notification consisted almost entirely in the creation of gangs of labourers on the agricultural estates destined exclusively for sanitary work, and in the institution of a sleeping sickness commission made up of the *administrador* of the *concelho*, the health officer, the president of the municipality, and two planters. According to the wording of Article 19, this Decree in its working was to be regulated by the Government of the colony, and it came into force only on July 22, 1912, under notification No. 208, over the signature of Governor Marianno Martins.

By this last notification, apart from purely administrative provisions relating to the scale of penalties, the sanitary gangs prescribed were to be governed, as regards organization, by Article 5 of the Decree of April 17; the time allowed for beasts of burden to stand in the streets of the town was limited to thirty minutes, dogs were only to be allowed to run about at liberty during the night, and the 10 per cent. proportion of serviçaes who had to wear sticky cloths on their backs was re-established.

The definite organization of the Official Brigade, whose services had been initiated in February, 1911, was only legalized by the Decree of the Minister of the Colonies of August 17, 1912; the number of serviçaes of the brigade was raised to 300; technical and administrative directors were appointed, the former being the health officer, the latter the officer commanding the detachment. And, thenceforward, the cases in which the brigade might render services to private individuals were more precisely defined.

These measures came into execution on February 23, 1911, on publication of the first notification by the Provincial Government. Governor Miranda Guedes then came to Principe, accompanied by Dr. Bruto da Costa, and did his best to convince the estate-owners of the advantages they would gain by rigorous compliance with the legislative provisions just promulgated. The brigade, then composed

of only forty-five labourers, lost no time in setting to work on the removal of noxious vegetation from the waste lands of the State and on clearing a belt round the isolation hospital for sleeping-sickness cases and the native houses in its vicinity.

It was at once seen that certain measures, the carrying out of which rested with the planters themselves, could not possibly be enforced for want of the necessary appliances. Thus, the protection of dwelling-houses and stables by means of gauze wire netting, which according to law had to be effected within fifteen days, could not be arranged for, as sufficient material for the purpose was not obtainable in the market. Another measure impracticable to its full extent was that relating to the supply of viscous cloths to all serviçaes engaged on work in the field. The enormous amount of cloth this demanded, seeing that the garment had to be replaced daily, not to mention the hindrance it proved to those wearing it when at work, was a serious difficulty. And on the other hand it was found necessary to limit the period of isolation of individuals infected to the stage when the parasite was found to have totally disappeared from the peripheral blood, with subsequent surveillance of each case by means of periodical examinations of the blood. It was, moreover, found unreasonable to compel the poorer native planters to carry out the protection of the dwellings by means of gauze wire netting; and, finally, it was seen that the period for the first injection of atoxyl following a glossina sting must be shortened.

These and other practical difficulties were at once remedied by a fresh notification, dated March 16, 1911, suspending the penalties for non-compliance with the preceding one, in view of the lack of wire-netting in the local market and the delay in the execution of orders for supplies. The number of labourers who had to wear cloths smeared with viscus was reduced to 10 per cent. of the gang actually at work out of doors, and seven hours from time of being stung was made the maximum period of delay for the atoxyl injection prescribed. The other subsidiary modifications already cited were also incorporated in the order.

The planters now complained of their inability to fulfil the injunction requiring them to reclaim their waste lands, for want of labour, and a compromise had to be made to afford them the number of men required for this purpose, as soon as the interdict upon importations into the island of Principe could be raised. The number necessary was

estimated at over 2,000, irrespective of those wanted for the filling of the blanks constantly occurring in existing establishments.

After forty days of closure, the island port was again opened to immigration, but up to the conclusion of the work done towards extinction of the epidemic most of the estate-owners had failed to get all the hands they wanted. In some cases this was due to recruiting difficulties; in others to want of means; and occasionally for no intelligible reason whatever. The Decree of April 17, establishing the strength of the fixed gangs for sanitary work, often proved a dead-letter, and the Medical Mission never succeeded in inducing the planters to strike off permanently from agricultural work a reasonable number of their men for these duties.

Up to the middle of 1912, the stage at which the campaign had attained its greatest activity and the important estate of Porto Real had started work on the extensive programme of sanitation now completed by it, the people whose attitude of passive resistance to the demands of the sanitary authorities had contributed most to the persistence of lamentably insanitary conditions in the colony were the large proprietors themselves, much of whose land had not even been brought under cultivation.

Government was likewise responsible, by its delay in raising the official brigade to the strength considered indispensable from the first and officially prescribed later on in the Decree of August 17, 1912, a delay lasting till 1914, for depriving the Medical Mission of the means of wiping out the epidemic within a much shorter time. The earliest and most notable task of the brigade was that undertaken on the native properties, their owners, rich and poor alike, standing by with folded arms, not considering themselves bound, even morally, to lend a hand towards the accomplishment of a campaign of such vitally general interest to the community. Later on the brigade took up the task of sanitating the properties of the Europeans who applied for its services but had not the labour force sufficient for its performance on their own account; also of those owners in whose cases compulsion had been applied for non-compliance voluntarily with the injunctions of the sanitary and administrative authorities.

In dealing with the native planters an interesting and characteristic trait was revealed. As soon as these good people grasped the idea that proof of poverty was necessary to secure the gratuitous services of the sanitary brigade, they provided the requisite evidence by dis-

missing the few serviçaes they had in their employment, and thus, *in formâ pauperis*, secured not merely the clearing-up of their lands, but of their plantations as well, free of all charge to themselves.

For a long time the need for provisions complementary to those of the Decree of April 17 was felt. The promulgation of these rested with the local government, and more than once the sanitary and administrative authorities represented how sadly their usefulness was being restricted by the lack of a regulation establishing, among other things, a graduated scale of fines. The regulation they asked for was only granted them in July, 1912, and only at that stage did the law begin to be really operative. But even then, and for long after, it was felt that the courts displayed great dilatoriness in giving effect to it, for where the persons convicted chose to resist payment of the fines, execution proceedings were tardy in the extreme; so much so that the moral force of the law itself was to a great extent vitiated.

The local government notification of February 11 laid it down, and the same provision appeared in Article 3 of the Decree of April 17, that the medical officers employed in the extinction of the epidemic should make a quarterly examination of the blood of all the serviçaes and other persons employed on the agricultural estates; and they were at the same time authorized to make a similar examination of the animals worked thereon, the results of these analyses being taken as a guide either for the purpose of segregating and compulsorily treating the former, or of treating or slaughtering the latter, when found to be carriers of trypanosomes.

It was never found practicable to give effect to this part of the law. During the first months of the campaign the number of doctors permanently on duty in the island was only two; this number was subsequently raised to three, but not until October, 1913, was it increased to four, in accordance with the provisions of the Decree of August 17, 1912; and it was only from that date that the Mission obtained the services of two qualified hospital assistants to help in the microscopic examinations, one of whom turned out to be utterly useless for the work in question.

At the beginning the Mission only possessed two microscopes, one of which was the private property of one of the doctors.

From June to August, 1911, two medical men carried out 572 examinations of blood, all of the human subject; in September of the same year 281 persons were examined; in October 292 persons and

36 animals, there being, from September onwards, three medical men in the island.

From August, 1912, to May, 1913, three medical men examined the blood of 3,992 individuals, or nearly the whole population of the island, and of 206 animals; from October, 1913, to June, 1914, four doctors examined 3,904 persons and passed in review, twice, all the animals on the island, examining the blood of 197 on the first occasion, and of 255 on the second.

Practically, then, each doctor, with his clinic of a certain number of estates to look after, and one of the zones of the island under his supervision, cannot put in more than from 150 to 200 rigorous examinations of thick blood-films (Ross-Ruge). So that it would only be possible to accomplish the quarterly examination of the whole population of the island, the average of which has of recent years been over 4,000 persons, and of all the domestic animals living there, as proposed by the Delegate of Health in January, 1913, were there a staff of four permanent medical officers, and the same number of hospital assistants duly instructed in the reading under the microscope of that class of preparations.

The medical officers who lent their services in the extinction of the epidemic were, in 1911, Pinto Meira, Cupertino de Andrade (replaced in October of this year by Correia dos Santos), Gonçalves Salvador, and Bruto da Costa, the last-named first as Inspector of Services, then as Delegate of Health.

In 1912 Drs. Guilherme Vieira, Correia dos Santos, Soares de Vilhena, and Bruto da Costa, the last-named as Delegate of Health and Chief of the Mission, from August, 1912, onwards.

In 1913, Dr. Vilhena having died, Araujo Alvares was appointed to the Mission, and in October of that year it was increased by one member, Dr. Firmino Sant' Anna; so that to the medical men who sign the present report it has fallen to notify in 1914 the disappearance of the *G. palpalis* from the island, and the extinction of the epidemic of sleeping sickness.

Official Sanitary Brigade—its Organization and Administration.

The first men who composed the brigade, numbering 43, arrived, as we have said, in Principe on February 23, 1911. They were all prisoners of war and delinquents sentenced to penal servitude, and were brought from San Thomé by order of Governor Miranda Guedes.

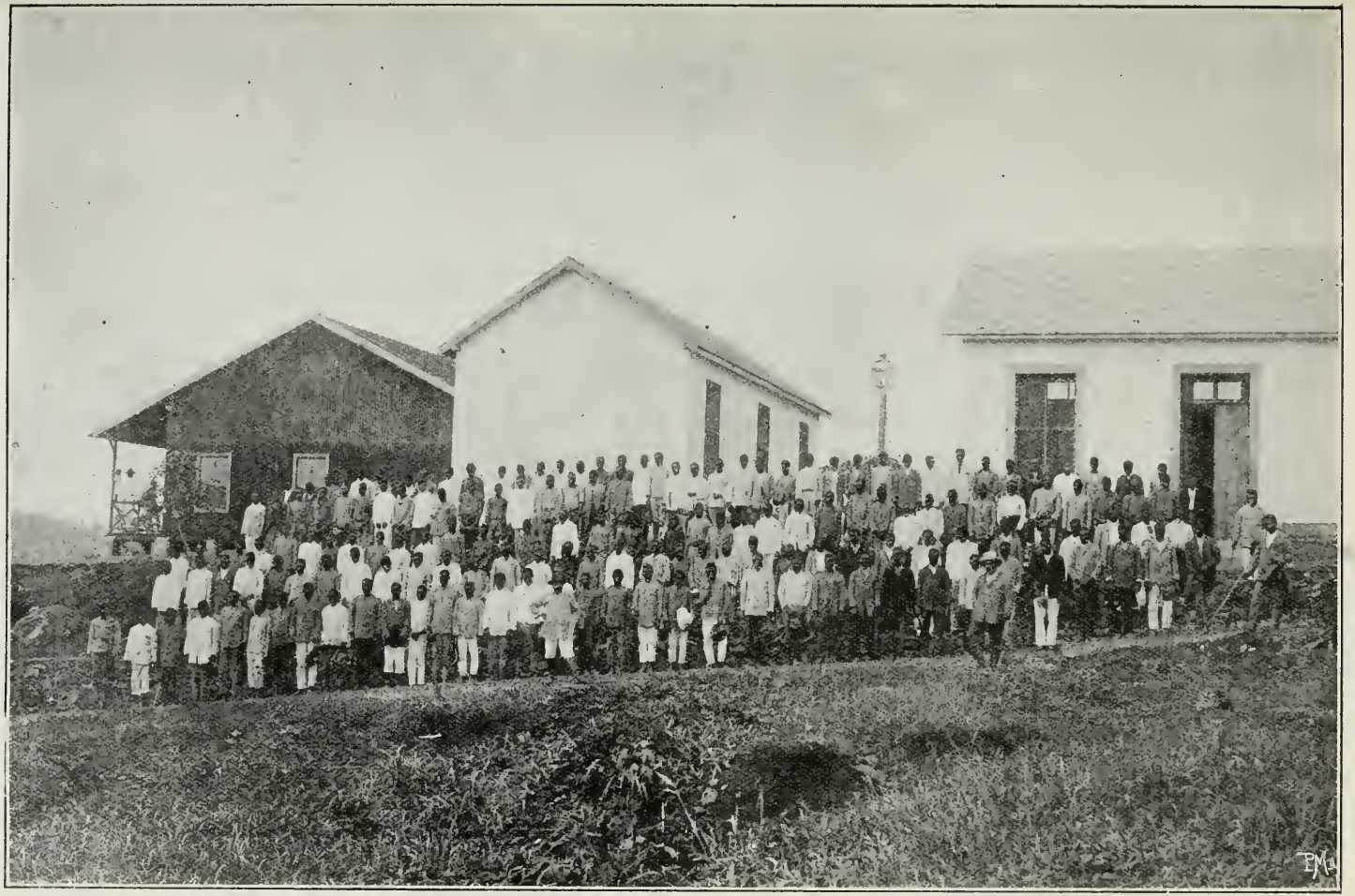


FIG. 22.—MEN OF THE OFFICIAL SANITARY BRIGADE IN 1914; TAKEN AT THE HOSPITAL AT PRINCIPE

It was with this little nucleus, under the orders of a European overseer, that work was begun. It became at once manifest that it was not with so tiny a number of hands that an intensive attack could be made on the forests and scrub jungles of the native lands, these all round being nothing but so many prolific sanctuaries of pig and fly.

In July, 1911, the health officer of Principe proposed the increase of the strength of the brigade up to 300 men, foreseeing that even that number would not be sufficient, having regard to the shortage of hands from which the European estate-owners were suffering; a matter which often caused many of them to requisition the services of the brigade to enable them to carry out the measures enjoined on them by law.

As the local government was not empowered to hire labour for this purpose, and could only dispose of the prisoners and the serviçaes sentenced to punishment by the Curator's court, the number of the brigade could only be raised to about 100, and this strength, with occasional fluctuations, was maintained up to March, 1913. Every month the serviçaes who had worked out their sentences would leave, and would be replaced by others sent from San Thomé; as for the prisoners of war, they mostly remained until the end of the campaign.

The proposal of the health officer, who represented also the opinion of the sleeping-sickness commission convened to consider the matter, only passed into law in August, 1912, notwithstanding the urgent representations of Governor Leotte do Rego to the Central Government. According to the Decree relating to it, the composition of the brigade was to be: 300 serviçaes; 1 European overseer; 1 hospital assistant; 1 technical director—the health officer; 1 administrative director—the officer commanding the detachment; and 8 soldiers to guard the serviçaes.

In April, 1913, there were added to the brigade 73 Indian prisoners of war, raising its strength to 182 men, without any great benefit as regards work, however, for these people, physically weak, in bad health, dirty in their habits, and altogether devoid of habits of industry, did nothing, and proved a real hindrance to the working and discipline of the whole body; later on they were transferred to the town, where they rendered some scanty service in the way of scavenging.

In October, 1913, seeing that the numbers of the brigade were still short and much below what had been prescribed by law, Governor Botto Machado managed to get 40 Caboverdeans engaged on contract,

Fig. 23.—Camp of Official Brigade on Roça Azeitona (1914): Overseer's Quarters.

on the terms prescribed by law for the acquisition of labour for agricultural work, and these began to arrive in the island in November of the same year. In that month the brigade had a total of 238 men, and in the months which followed it was increased, so that from February, 1914, onwards it had an average of 300 serviçaes; in June of the same year the natives of India were transferred to San Thomé, 316 men thus remaining.

At first, the European staff in the field consisted of a single overseer; but it was soon manifest that, between the extra work put upon the brigade and the necessity for dividing it into two sections so as to work simultaneously in different parts of the island, one man was not enough. So a second overseer was engaged in May, 1913. The rank and file of the brigade was composed of Angolan natives, some being serviçaes contracted for the roças of San Thomé who had committed themselves while there, and had been convicted and sent to Principe to work out their sentences, the rest prisoners of war shipped direct from Angola. Besides these, there was always a certain number of natives of San Thomé itself, and these increased as time went on. They were criminals or vagrants sent to the brigade with a view to their reformation. The 73 Indian prisoners already mentioned likewise formed part of the brigade, with 40 Caboverdeans on free contracts, and a few native prisoners of the same origin.

From a disciplinary point of view, the most troublesome and worst conducted of all were the natives of San Thomé, whose brigandage and insubordination sometimes endangered the life of the senior overseer, Russo de Oliveira. His marvellous energy was often severely tested by that band of malefactors, some of them men of the worst possible type.

It is only just to record the fact that though the brigade had been made a cesspool for the scum of the two islands, and rigid supervision on the part of the five or six native soldiers on duty with them was impossible, also though its members had to sleep out in open camps and extemporized quarters, there were few complaints of housebreaking by night throughout the three and a half years of its stay on the island.

From the point of view of usefulness, the best record made was that of the Angolans, the extensive clearings that fell to their share being a rough and dangerous task. In opening out the virgin forest, the continual bringing down of great trees, hacked through by the

Fig. 24.—Another View of the Official Brigade Camp on Roça Azeitona, in 1914.

machete, exposed the labourers to frequent danger, for at any moment a slight inattention might result in a fatal accident. To the skill of the senior overseer is ascribable the rarity of any such disaster throughout the long period of active operations. In 1913 there was one case ending fatally for the serviçal concerned. It happened during the absence of the overseer, Oliveira, who had had the misfortune, through a shooting accident a day earlier, to lose one of his hands. Later on there were two fatal cases among the Cabo Verde serviçaes, comparatively new to this kind of work; these also took place during the absence of the overseer.

The oldest and weakest men, so long as they retained the complete use of their lower limbs, were detailed for fly-catching, and went about their work wearing the customary viscous cloths. Those who were not equal to even this easy task remained in camp and did what light work they could.

The housing of the brigade was arranged for in temporary camps, as the nature of their work compelled them to shift from place to place. From May to August, 1911, the brigade was housed on the Roça Cascalheira, whence it went on to Pró-Vaz in the Roça Aguiem. There it remained up to December of the same year, moving on to the Roça Azeitona, and staying there till April, 1912. In that month it was sent to the sleeping-sickness isolation hospital, now the general hospital, where it worked until July, 1912, cleaning up the lands in the eastern part of the island. From July, 1912, to February, 1913, it was again at work on the Roça Azeitona, and then passed over to the Roça Porto Real, where it went through the sections of San Matheus, Pincaté, and Fundão in succession, returning once more to Roça Azeitona in May, 1913, where its main body still (September, 1914) remains.

In July, 1913, a group of fifty men was detached to Praia Baleia, on the Roça Santo Christo, to clear more effectually the native lands on the east. It worked under the orders of sub-overseer Alegre, and returned to Azeitona in August. In March, 1914, a similar detachment was sent to the same place, composed of contract labourers from Cabo Verde. It was withdrawn in July.

Last August seventy men were sent to San Matheus, Porto Real, to do the clearing required there. The rest of the brigade remained on Azeitona engaged on various works of conservancy, and finished off some incomplete clearing and felling.

As these men, by the nature of their duties, were continually ex-

posed to infection, the worst centres of the glossina being their field of operations, they had to receive fortnightly injections of atoxyl, 0·6 gramme at a time. To this precaution may be attributed the small number of cases of infection among them, for between February, 1911, and August, 1914, only four men, out of four hundred or more who had served in the brigade, died of sleeping sickness. At this moment there are only seven sick among the ranks of the survivors.

TABLE III.—STRENGTH OF THE OFFICIAL BRIGADE, BY MONTHS, FOR 1911-1914.

Months.	*Years.*			
	1911.	1912.	1913.	1914.
January	—	109	109	256
February	43	104	109	290
March	33	104	118	290
April	76	109	182	306
May	76	109	173	309
June	109	109	173	316
July	92	109	173	—
August	92	102	173	—
September	86	106	173	—
October	86	109	173	—
November..	105	106	238	—
December	102	106	256	—

Work in the Field—Jungle Fellings and Swamp Reclamations.

The steps taken in Principe during the present sanitary campaign towards extinguishing the disease consisted principally in the clearing away of herbaceous and bushy vegetation, in the opening out to the sun's rays of the margins of watercourses and swamps, straightening out and levelling the banks and the beds of these, draining and filling swamps, and forest fellings on a large scale.

The work of cleaning and cutting away herbaceous and bushy undergrowth—locally known as *capina*—and the embanking of the course of various little streams and rivulets, are matters which have to be seen to periodically, at least twice a year, so as to satisfy hygienic requirements. In the rains, which in some years extend beyond the eight months of classic tradition, trailing vegetation spreads pro-

FIG. 25.—HOUSING OF A DETACHMENT OF THE BRIGADE ON PRAIA BALEIA, ROÇA SANTO CHRISTO.

Fig. 26.—Mouth of the Manoel Lima Stream (Roça Sundy), after Cleaning.

digiously, and re-forms thickets which at all times have proved a source of insalubrity to the island; while the impetuous floods damage the smaller works intended to relieve the overflow of the surface waters.

In cacao plantations belonging to Europeans, as a rule very carefully cultivated, the cutting of the spontaneous grass-crop under the trees is undertaken at least twice a year, and this, added to the pruning of the cacao-trees themselves, usually done in the rainy season after the principal harvest has been gathered, insures fairly permanent conditions of hygiene to these planted lands. This, however, is far from being the case with those of native owners, in which the cacao, to begin with, is planted without method, and allowed to form a jungle of sickly and overgrown saplings with all kinds of noxious vegetation under it. These owners rarely take the trouble to do any cleaning or weeding, and it is not unusual for their plantations to develop into something undistinguishable from *capoeirão*.

The total area of these native plantations cannot be far short of $4\frac{1}{2}$ square kilometres. Work upon them has had to be carried out almost exclusively by the official brigade, for under the Government provision exempting the poorer classes from all charges on this account, native proprietors, almost without exception, have refrained from performing any agricultural operation beyond gathering in their cacao crop.

The removal of bushy and herbaceous vegetation, in lands formerly felled and exhausted by earlier cultivation—among others, old fields of sugar-cane and manioc—has been performed during the last three years with a certain amount of regularity, either by the brigade or by the labour force belonging to the estates. Grass-cutting and scrub removal are carried out by means of the *machim*, or *catana*, the agricultural implement in general use in most tropical countries. It is a long knife with a short handle, weighing about a kilo; its blade measures about 45 centimetres in length and 6 in breadth. It can be used as a hatchet, a hoe, a pruning hook, or, if sharpened down to a cutting edge, as a sickle. It lends itself admirably to the kind of work to be done where grass and bush of varying dimensions, shapes, and toughness have to be dealt with at one and the same time.

The training of the streams, the removal of the trees that may have fallen across them, of the stones that may have been displaced by the floods, of the lands shifted by the erosive action of the waters, and the clearing of vegetation from their banks, as well as some minor

Fig. 27.—Mouth of the Sundy Stream, after Cleaning.

drainage work, are all of them operations to be performed over and above the clearing of grass and bush.

As the rains persist throughout the greater part of the year, the effects of these small improvements are very transitory, a few weeks of heavy rain sufficing to re-establish things as they were before; weeds spring up and develop rapidly, brooks get blocked, and drains fail to serve any useful purpose. The work done in or about the *gravana* is more lasting, for during the dry season there is, so to speak, a pause in the febrile activity of natural forces; the weedings that precede this season are those leaving the most lasting results; thus, the best practice to follow is that of two annual operations—one in the middle of the rainy season, the other at the end of it.

The improvement of the larger swamps was one of the most laborious pieces of sanitary work done. As we have said elsewhere, the swamps came under three distinct categories: swamps of the natural depressions of the ground, with or without a covering of forest; marshes in the hydrographical basins; and mixed swamps, the last-named being in the littoral belt.

The work done to rid the island of these consisted mainly of drainage, more rarely of reclamation by earthing them in; in the first place because the former process was less expensive, being facilitated by the natural lie of the ground, and again because no technical adviser was available, nor were the instruments necessary for large-scale earthworks forthcoming.

Part of this work was done by the labouring establishments of the estates, and part—an important part—by the official brigade, whose services were requisitioned and paid for by the proprietors. As a preliminary operation, extensive forest cutting had to be effected, since the swamps were often hidden under a screen of arboreal vegetation.

The system adopted for drawing off the water was that of main drains discharging into the nearest river, with feeder drains leading into them. In both respects, seeing that we had no technical adviser, we followed the trace indicated by the natural slope of the land, and by the direction taken by the surface water; in the beginning straight-cut channels were made, but these very soon became blocked by the earth washed down from above. After this experience, we reserved the straight drains for the flat lands which had a more or less uniform slope.

The total area of land submitted to drainage and reclamation

Fig. 28.—Praia Cornelia, on Roça Sundy, after the Clearing of the Secondary Growth.

Fig. 29.—Felling and Clearing on the Corvão Stream, Roça Porto Real.

Fig. 30.—Draining and Straightening of the Ribeira Lama, on Roça Sundy.

during the sanitary campaign amounted to about 4 square kilometres, 3 of which lay in the northern, and the rest in the central zone of the island. Of this class of work the most important example was the drainage of the hydrographic basin of the Ribeira Dumú-Izé, containing the chief breeding-ground of glossinas in the island.

All the upper part of this basin, contained in the southern section of the northern plateau of the island, between the Ribeira Lama and part of the Dumú on the west, the hill of Pincaté and the stream of Terras da Fabrica on the east, bounded on the south by Montalegre and extending northward along the main stream of the Ribeira Dumú-Izé, used to be a huge marsh, covering about 2 square kilometres, in the centre of which rose the hill of Selu; into this bog formation there flowed, on one side the Ribeira Lama, on the other the Benedicta and the Terras da Fabrica, uniting to form the Ribeira Gallinha. The latter poured its waters into the marsh, which thus gave it indirect communication with the Ribeira Dumú. These flooded lands, covered with forest and secondary jungle, sheltered legions of swine, and even oxen used to wander at will among them.

To the execution of these works, the managers of the Roças Sundy and Porto Real lent their co-operation. On the Pincaté side the greatest difficulty lay in the high level of the pent-up waters—in the rainy season 5 metres in depth at some points—also in the thickness of the bed of mud, combining to make it impossible for the serviçaes to enter the place for work. Preliminary works had therefore to be undertaken, in the shape of a tunnel through the Pincaté hill to establish connection between the pot thus formed and the basin of the Ribeira dos Frades, or Ribeira Manoel Affonso, as it was named at that point, close to the foot of the hill.

This tunnel had been begun in 1908 by Senhor Manoel Abreu, but had been left unfinished until 1911, when it was resumed and completed. Shortly after, it was found not to give a sufficient outlet to the waters held in check behind Pincaté, so its floor was cut a metre deeper and the land beside the upper end of the tunnel earthed up, making the ground there firmer and more accessible to the labourers. The drainage of the lands was then completed by means of a system of cuts, the two principal having an approximate length of 1 kilometre and a breadth of 2 metres throughout, with a depth of from 1 to 1·5 metres. These cuts received numerous secondary channels or feeders all along their course, and flowed into the Ribeira Gallinha, the entrance

Fig. 31.—Work of Cleaning up on the Ribeira Lama, Roça Sundy.

Fig. 32.—Cutting made in Bed of Ribeira Dumé, Roça Sundy, for the Freer Flow of its Waters.

Fig. 33.—Outflow Drain of Ribeira Gallinha, Roça Porto-Real.

of which into the Ribeira Dumú, blocked for many years by alluvial deposits, was reopened by the brigade by means of a canal cut across the lands of the native proprietor, Gabriel Fernandes.

The tunnel just mentioned runs north-west to south-east, measures 150 metres in length, 3 metres in height, and 1 metre in width.

From the west side, to the south of Selu and on the lands of Sundy, there are drains running down to the Ribeira Lama, but all this complicated system of channels only succeeded in producing its full effect after the Ribeira Lama and all the upper reaches of the Ribeira Dumú down to the bridge of Oqué Caça had been deepened and their banks straightened out. A number of fallen trees and roots had obstructed this watercourse, blocking its channel and reducing its utility as a drain almost to zero. But now that the latest work of the brigade has been finished, its waters run in a steady current.

At various points in the basin of the Dumú-Izé, other drainage works have been brought into existence, those on its right bank, on its lower course, beside Roça Ribeira Izé, being specially worthy of remark. They were initiated by the brigade in March, 1914, and brought to completion by the estate manager, as also were similar works on the left bank, near Ribeira da Boa Entrada on the Roça Sundy.

In the north of the island, among many other things done, we may mention the following:

Drainage of the Boa Vista swamp on Roça Santa Rita by means of a large central channel nearly a kilometre in length, with other secondary channels, flowing into the Ribeira de Santa Rita on the north coast. This work was completely performed by the managers of the estate.

Drainage of two big swamps on the north coast, near the Praia das Burras, belonging to the lands of Roça Paciencia, at the mouth of two little rivers falling into the sea there. This is a work done by the owner. On the same property there is an important drainage system, on the northern and north-western edges of the mixed swamp of Praia Grande, improving the already planted lands, where the waters of the springs and of the hillside streams used to get pent up.

This list of drainage works may be completed by the enumeration of those on the left bank of the Santa Maria, on Roça Praia Inhame, those of the former swamp at Pró-Vaz on the Roça Aguiem, some small drains at various points on the lands of the Companhia União do Principe, those of the swamp of Iola at the mouth of the Iola, on Roça

Fig. 34.—Drainage Works on Swamp of Oqué Tres and Ribeira Lama, on Roça Porto Real.

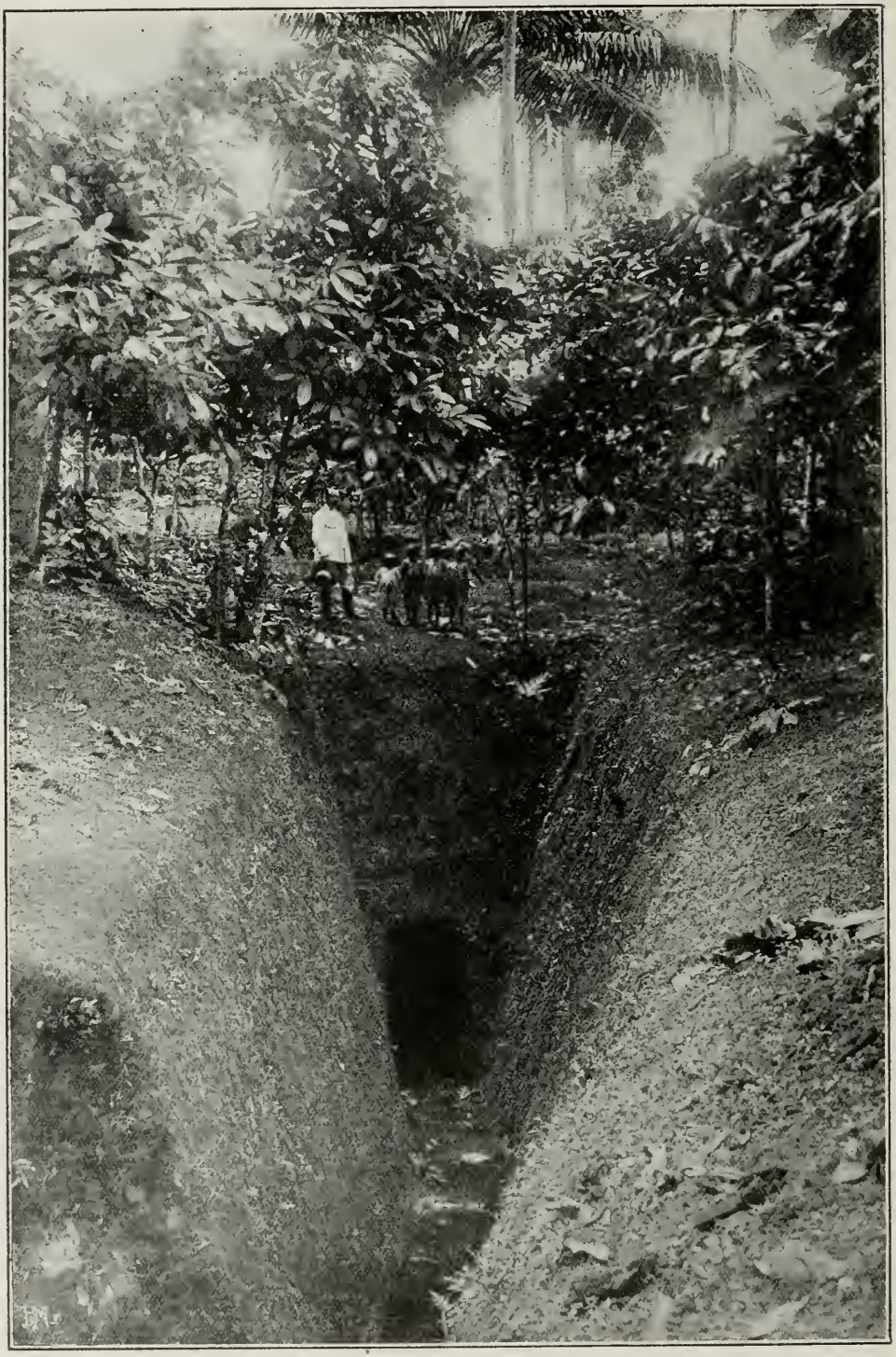


Fig. 35.—Entrance to Tunnel giving Exit to Waters of Swamp on Ribeira Gallinha, Roça Porto Real.

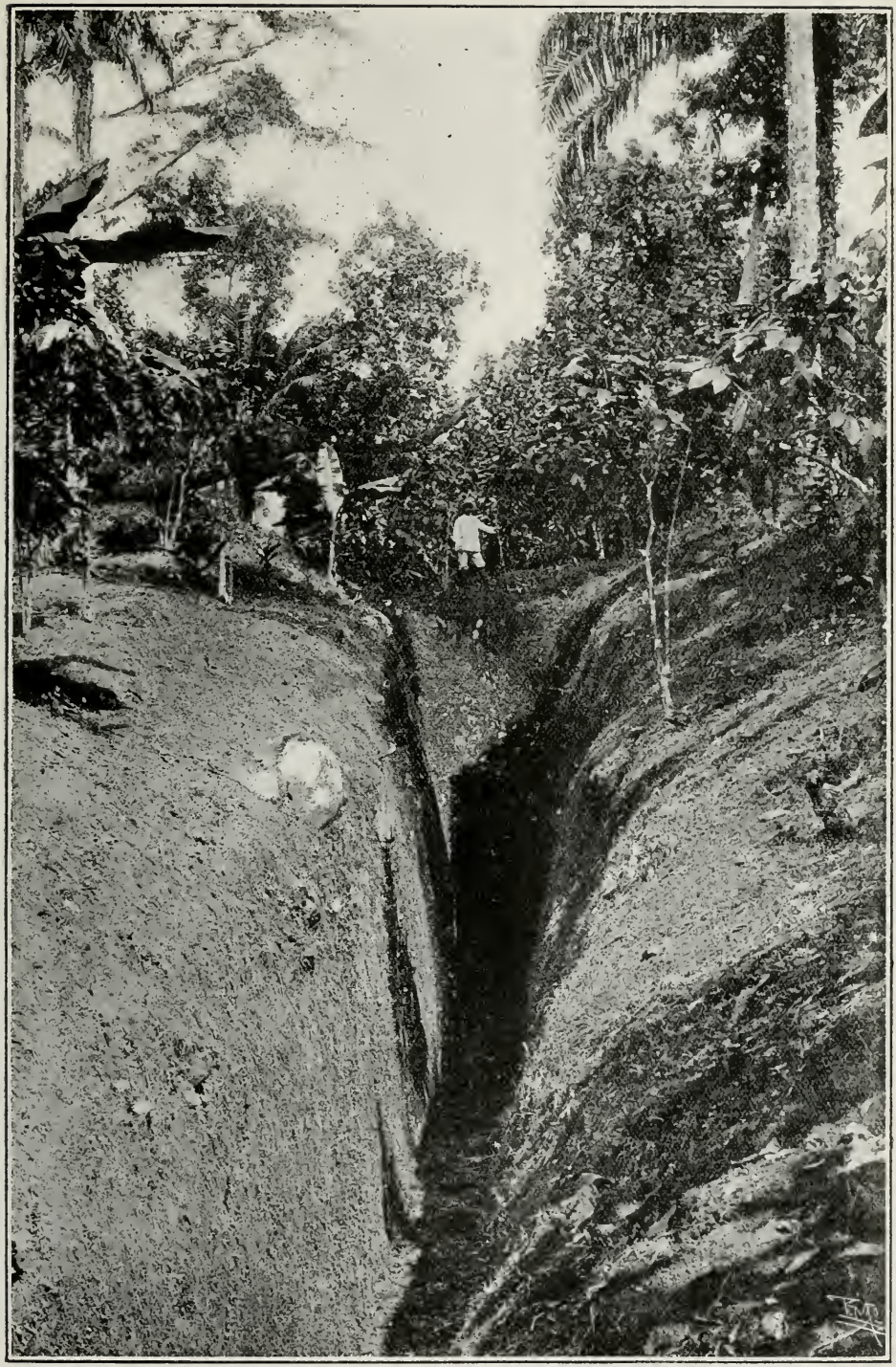


Fig 33.—Exit of the Same Tunnel.

Sundy, and of the lands of Alfama, on the northern coast, belonging to the same estate.

In the mixed swamps of the northern part, notably those of the mouth of the Ribeira de Santa Rita and of the Praia Grande, all the vegetation on their margins has been cleared, they themselves have been regularly banked up, trees and bushes brought down by the floods have been removed, and finally, on the latter in particular, coco-nut palm plantations created around their edges; the results of all this as regards the expulsion of the glossina being excellent.

In the Praia Grande swamp, the sand-dunes which gather often close the outflow channels, and at the same time prevent the entrance of the tide from the ocean. The manâgements of the two adjoining estates, Sant' Anna and Paciencia, have therefore agreed to carry out a joint clearing of the bar, which, by the way, takes place automatically in the height of the rains by the force of the waters themselves, but has to be done periodically at other seasons.

In the central zone of the island, the work done on the Roça Porto Real under the direction of the present manager of the Company, Senhor Manoel Abreu, deserves notice for the method with which it has been executed. Within this estate, and on the west coast, the southern side of the River Banzú has been banked up close to its mouth, an area of about 5,000 square metres having been reclaimed with stones and sand, in some places to a depth of 3½ metres; on the northern bank of the same river, over a length of more than 1 kilometre and a riverside band of from 30 to 200 metres in breadth, a system of multiple drainage by transverse channels has been completed, its length totalling more than 2,000 metres. Though this was formerly one of the most infested areas, not a single glossina has been found in it since March, 1913.

Beside the Praia da Lapa, also on the west coast, at the mouth of a little stream, a similar piece of reclamation work has been done, in clay and sand, a dip extending over 2,000 square metres, with a maximum depth of 2 metres, having been filled in. The result of this work, completed by the drainage of the banks of the stream in question and the clearing from the adjoining lands of scrub jungle, has been the total disappearance of the glossina ever since February, 1913.

In the valley-lands of San Joaquim, 1,500 metres to the north of the assistant's headquarters in the subdivision of that name, there used to be a large swamp in a basin 40 hectares in extent, with a rocky bottom covered with forest; this swamp was a terrible focus of fly, and

Fig. 37.—Drainage Works on Swamp of Boa-Vista, Roça Santa Rita.

Fig. 33.—Drained Swamp of Praia das Burras, Roça Paciencia.

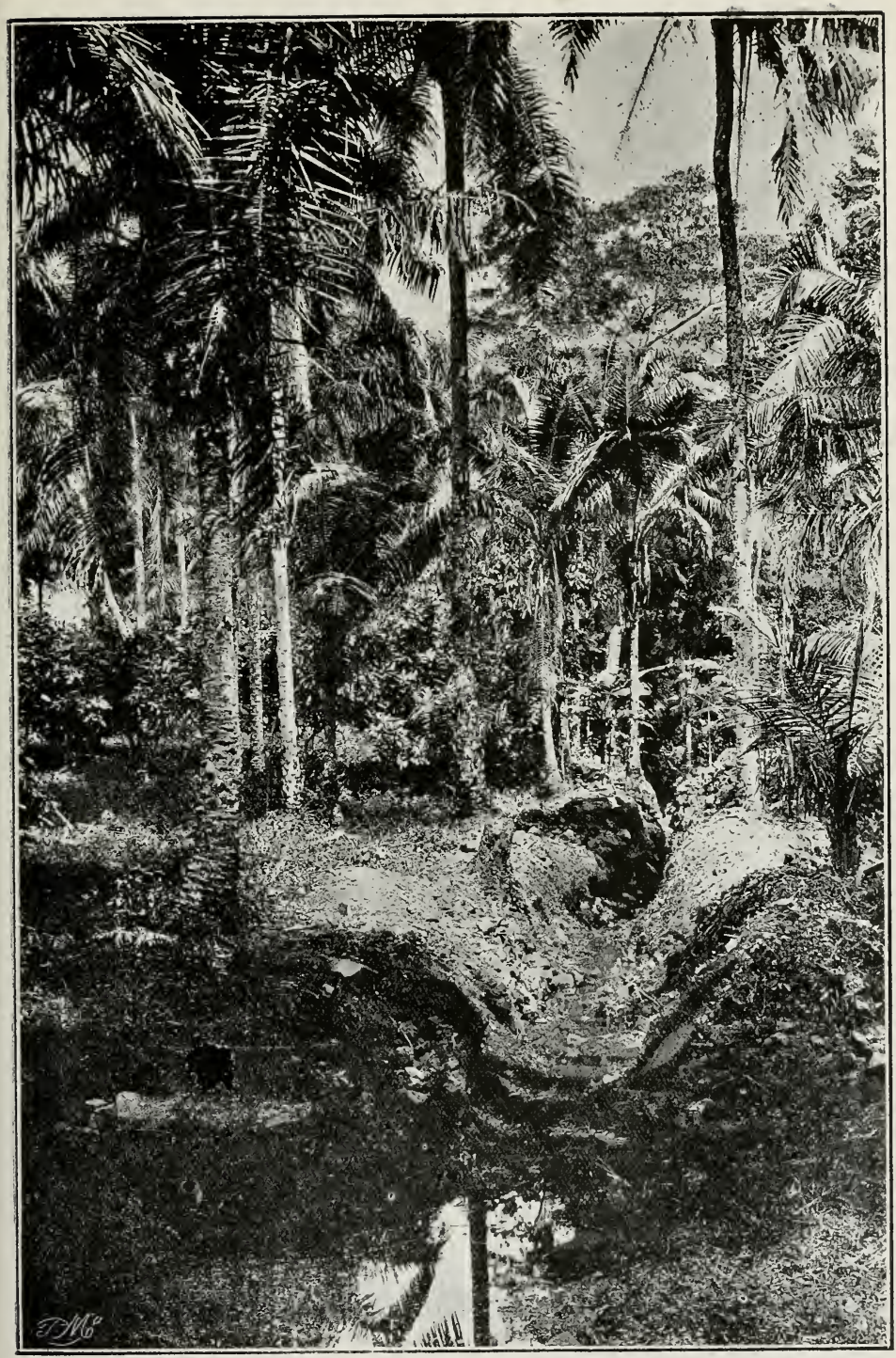


Fig. 39.—Rock Cutting for Outflow from Swamp Bacharel, Roça Porto Real.

the cause of much loss of life on the property. Once Senhor Abreu had got rid of the forest, in the middle of 1912, he set to work to cut a ditch 2 metres deep and 2 metres broad, running from east to west, with the object of establishing communication with one of the affluents of the Rio Bacharel. This ditch was made throughout by means of blasting, and even then it had to be deepened in parts before the work could be considered complete. The length thus cut was 106 metres. and it had to be further deepened for a length of 20 metres; up to the beginning of 1914 no less than 285 kilogrammes of blasting-powder had been spent on it. The last glossina found there was caught in September, 1912.

In the western part of Roça Porto Real, the sides of the Rio Bacharel were further drained, at Prainhas and at the Praia da Maria Correia. In the central part of the estate, on the foothills of certain elevations belonging to the Papagaio range, several points where the water from springs on the upper slopes tended to stagnate had also to be drained after the necessary fellings of forest had been effected; this was the case with two swamps lying round the base of the Papagaio peak, one of them to the south, the other between that peak and that of Fundão; also with a third to the east of the peak of Fundão, and a fourth at the foot of the Pico João Dias.

The low riverside lands of the Papagaio were drained both on the right and on the left bank; on the Porto Real side there is a series of small works to this end, from the confluence of the Ribeira Marmelo up to a point near the cemetery in the vicinity of the village. On the opposite bank, both on the Roça Terreiro Velho and the Roça Bella Vista, especially on the latter, many important works have been carried out, to the benefit not merely of the plantations themselves, but of the island in general, seeing that all those lands were hotbeds of glossinas.

The valley of the Forca, or Damião, as it is called in its upper reaches, was drained, first on the Roça Terreiro Velho, where it used to form the swamp known as Babilonia, and has now been drained, down-stream, through the Roça Nova Estrella.

In the Roça Abbade an existing swamp close to the beach has been drained and reclaimed by means of a wide paved channel. A short distance from this a large mixed swamp with a muddy bottom, known as the Praia Salgada swamp, which used to be flooded at high tide, has also been cleaned up and freed from obstructions.

Fig. 40.—Drainage Works on Right Bank of Papagaio River, Terreiro Velho.

Fig 42.—Extensive Clearing in Swampy Forest of Ribeira Lama, Roça Porto Real.

On the banks of the Ribeira dos Frades, some small drainage works have been constructed, both on the San Matheus side (Roça Porto Real) and across the stream (Roça Cuba). In its lower course this stream is partially canalized between walls of loose stone, and the muddy portions, which used to be left uncovered at low tide, have been partially reclaimed. The last-named work was allotted to the prisoners in the civil jail as their task, and is not yet finished.

It should be emphasized that many of these works, demanded by the estate owners in the name of public health, have directly reverted to the benefit of agriculture, inasmuch as they have enhanced the productivity of several of the existing plantations which formerly suffered from excess of humidity in the soil, and have also opened up to cultivation many tracts of country not hitherto available.

The more important fellings, in the accomplishment of which the brigade has played a considerable part, have for the most part been carried out in the forests, or *obós*, which used to cover a great extent of the northern plateau of the island, including part of the Roça Sundy, the marshy zone of the upper waters of the Ribeira Dumú, the Montalvão, Azeitona, and a number of small native properties. An extensive riverside strip, more than 500 metres in breadth, in the west and north of Roça Sundy, in which plantations had already been formed, has been felled; and fellings have also been undertaken in the northern coast-lands, including the Roças Pau Fita, Cascalheira, and Campainha. In the central portion of the island the woods covering the slopes of the hill Oqué Nazareth, several patches of forest at the foot of the Papagaio range, and the forests on the banks of the River Papagaio itself, have likewise been felled. All through the island a great number of secondary fellings have had to be undertaken inside the cacao plantations, where shade trees had been left thicker than was desirable.

During the three years of the campaign against sleeping sickness, the area of lands in which forest cuttings and removals of isolated patches of wood were effected exceeded 15 square kilometres.

These operations, in the case of virgin forests, had to be performed stage by stage. First of all, paths had to be made to admit the labourers by a preliminary clearing of undergrowth and a hacking through the lianas, or bush-ropes, which in most cases made these forests absolutely impenetrable. Once a passage was cleared, felling began in earnest. When the trees were brought down and laid out on

Fig. 43.—Clearing on Montalvo Plateau, Roça Praia Inhame.

Fig. 44.—Clearing on Dependencia (Out-Station) San Jeronymo, Roça Sundy.

the ground, they used to be broken up into sections, larger or smaller according to circumstances, but in such a way as not to leave branches or roots raised up from the ground to encourage the growth of secondary jungle. In local agricultural parlance, this is called *salting* the clearing. The débris of the felled forest was rarely burned, as this was only practicable during the dry season, and it was sufficient to leave its destruction to natural agencies, which generally disposed of it within two or three years, except in the case of very tough woods, such as *mondim : Pentachletra macrophylla* (Benth.).

Recognizing the inconvenience attending such methods, not to mention certain possible climatic perturbations, cutting down to the ground was not usually resorted to except in flooded lands, where the fellings had to be radical. The rule followed was to leave trees at from 6 to 8 metres' interval in the more elevated and exposed situations, and from 10 to 15 metres apart in the lower and more sheltered. Preference was given, in retention of these, to the more useful species in respect of their fruit or their timber; the *andim* palm, for instance, abundant in these forests, was largely spared everywhere, both for the slenderness of its lofty trunk and the small diameter of its crown even in the swampy bits. This working plan generally allowed of a levelling of the ground and a degree of aeration and ventilation sufficient to clear every glossina out of the region.

The hatchet men of the brigade were selected for their physical strength, the natives of Angola being the best suited to this class of work. The gang of these did not as a rule exceed fifty serviçaes. The overseer distributed them throughout the forest, posting them at distances exceeding the radius of the circumference within which each tree attacked by the hatchet must necessarily fall. The general method followed in the cutting of the trunk is that of two incisions on opposite sides, one above the other, so as to arrange that the fall of the tree shall take place where the ground is only slightly inclined and the crown of the tree extends evenly balanced in all directions towards the side of the lower cut. When the workers make the cuts, one above and the other below, they and the overseer know beforehand how the tree must fall, and with proper care and attention they can avoid accidents. On very sloping land, or where the centre of gravity of the tree is visibly on one or the other side, the idea, of course, is to take advantage of the fact, and make the incisions accordingly. The specimens whose dimensions are unusually great, or whose timber is

Fig. 45.—Clearing on Roca Montalegre.

Fig. 46.—Operation of Ringing a Tree by Fire amidst Cacao-Trees: Roça Sundy.

unusually tough, sometimes demand the combined attack of three or four hatchet men at a time.

As a general rule the trunk is incised at a height of 40 to 60 centimetres above the ground, thus making it easier for the men to get at it with their implements. The stumps left, in some species, as, for instance, the *muandim* or *mondim* (*Pentachletra macrophylla*), the amoreira (*Chlorophora excelsa*), the marapião (*Zanthoxylon rubescens*), the iza-quente (*Treculia africana*), the abacateiro (*Persea gratissima*), etc., send out stool shoots in a very short time, and cover the ground rapidly with bushy undergrowth and *capoeirão ;* but if the precaution be adopted of cutting these shoots two or three times and stripping the stump of its bark, the tree dies, and the decomposition which sets in very soon works down to the roots.

Fallen trees should, whenever possible, be " salted " when green; thus, not only the cutting of the trunks and branches becomes easier, but the growth of a terrible scrub jungle is prevented. If allowed to spring up, the labourers, later on, can hardly get into the place again. It has been observed that whenever fire has been set to the felled débris after it has become dry, and it has been reduced to ashes, the secondary bush grows with an even greater rapidity and creates a more vigorous forest than if left to itself.

For the destruction of isolated trees, a different process to that just described, known as *burning* (ringing) the tree, is much used in Principe. The operation consists in making a fire all round the base of the trunk so as to completely destroy a broad ring of bark; thus the circulation of the sap is interrupted, and the tree dies at once, its leaves falling and its stem becoming a withered skeleton. By their natural decomposition and by the action of wind and rain, these branches drop off one by one, as well as the principal limbs, so that in the course of two years, on an average, nothing remains but the dead trunk of the tree itself; and this, later on, almost invariably during a storm, comes to the ground. These dry trees, often with the lower part of their trunks devoured by fire, constitute by their persistence on the soil a permanent danger to passers-by. The accidents that have occurred in this way are by no means rare, but it is always better to employ this method, whenever trees standing in the midst of plantations of cacao have to be removed, as the injury done by the gradual fall of fragments is much less than by the fall of an entire tree with all its branches upon the standing cacao-trees of the plantation.

Death to all Pigs, Dogs, and Civet-Cats in the Island.

When the first notification was issued, forbidding the rearing of pigs in the island, and directing that all existing stock of these animals should be destroyed, some planters who owned piggeries conceived the idea that the best way to comply with the order was to set at liberty the swine they possessed. Thus they continued to have at their disposal all that they wanted without subjecting themselves to any legal penalty, as they could shoot them for their own requirements or those of their labourers whenever they wished. In this way the wild pigs on the island, already quite numerous enough, increased considerably, and spread over a much wider range of country. If, at first, when they were only hunted singly for food, it was not difficult to get them, it became so as soon as the animals found that the whole official brigade was arrayed against them. They took refuge in the dense clumps of vegetation and in the forests where the semi-obscurity effectually hid them, and their extirpation had to wait upon the progress of forest felling and clearing.

To this end, various sportsmen had to be posted, armed with rifles, round about the gang of labourers who were engaged in clearing the vegetation. These held the clearings and open bits of jungle through which the swine tried to escape, and killed many of the latter. It was in one of these battues that the head overseer Oliveira lost one of his hands, through an accident with a gun. Some of the larger and fiercer animals, finding themselves surrounded, would occasionally attack the hunters and injure them, but fortunately serious wounds are not on record. The serviçaes often came to close quarters with the animals and had then to defend themselves with their hatchets.

In the clearing of Cascalheira alone, between May, 1911, and the beginning of 1912, about 800 head of swine were killed; on the Roça Azeitona more than 200. On the Roça Sundy, from first to last, the number disposed of was not far short of 1,000, while, on their own account, in different parts of the island, the official brigade succeeded in killing no less than 2,500.

The area of the island most infested with wild pig was the northern; in the central zone a good many were found in the neighbourhood of the Papagaio peak, on Esperança, and on San Matheus. In the western zone some were discovered in the *dependencia* of Maria Correia

on Roça Porto Real, beside the Pico Meza, and also in Fundão *dependencia*. On the Roça of Terreiro Velho the animals were mostly in the piggeries; and in the south of the island, on the Roça Infante D. Henrique, there were some 200 animals, all in piggeries.

As their pursuit began in the north, many animals migrated towards the centre of the island, appearing in places where traces of them had rarely been seen before, as, for example, in the Roça Nova Cuba.

The predilection of the glossina for the pig is remarkable; on the occasions of the battues it was a common sight to find a great number of glossinas sucking the blood of the fallen and dying animals. The head overseer of the brigade, when encamped in Pró-Vaz, a *dependencia* of the Roça Aguiem, reported an interesting observation that he had made. The fly had completely disappeared from the vicinity after the extensive cleanings and clearings of forest made all round. It occurred to him to secure and bring home with him two little pigs, just caught, for his own eating. What was his horror, a few days after, when he was called by the men to look at his pigs, to find them both thickly covered with flies!

Latterly the animals have become very rare, and it has been necessary, to find even one or two, to call together the whole brigade and beat the bush on a large scale, with the help of men from the estates. It was in the damp lands of the old swamps of the Ribeira Lama and the Ribeira Gallinha that these animals hid to the last; in February, 1914, some dozens of them were seen on the lands of the native planter Gabriel Fernandes, and six were killed; in a battue in the same neighbourhood in July, 1914, eleven were disposed of. At date (August, 1914) the number of pigs remaining at large in the island cannot exceed twenty.

Stray dogs are likewise a terrible plague in the island; it has never been possible to make the natives keep their dogs locked up by day, and in this respect the European owners have not always been careful to obey the law. Glossinas are often seen sucking the blood of these animals, and the fact that they are frequently found infected by trypanosomes shows their importance from the point of view of collective hygiene.

The measures directed against stray dogs have borne useful fruit, for the number of dogs killed by the brigade, some by shooting, others by means of the hatchet, is over 2,000. On some days the slaughter

amounted to from thirty to forty. Latterly the dogs of the *forros* (native farms), knowing themselves to be hunted, have acquired the habit of hiding in the bush, choosing the remotest and shadiest retreats.

As a measure of justifiable precaution, it has also been endeavoured to exterminate the civet-cats, or *lagaias*, very abundant in the island. During the day these animals hide in shady places, and as a rule only emerge from their lair at night. As they see with difficulty by day, and their movements are slow, it has been easy to shoot them or cut them down with a blow from a hatchet, or knock them on the head with a stick, when discovered through the work of clearing or felling the forest. In the campaign the number of *lagaias* killed by the brigade was over 2,000.

It has not been ascertained that the glossina, perhaps on account of the smell exhaled by these carnivora, has any fancy for their blood. It has never been found feeding on them, nor, in more than a hundred examinations, has the animal itself been found to be a carrier of trypanosomes transmitted locally by the *Glossina palpalis*.

A determined war has been waged in the island against the monkeys that abound there, chiefly on account of the damage they do in the plantations. Their share in the nourishment of the glossina through their blood has been apparently *nil;* their insectivorous habits, and the fact that they pass the day perched high up in the tallest trees, undoubtedly explains this.

Similarly, *nil* has been the value of the field-rat, prodigiously abundant in the island.

One of the birds of the island used formerly to be under suspicion—one of the kingfisher tribe, known by the name of *chó-chó*—a bird of heavy flight, affecting shady places under trees in search of insects and grubs; but there is no evidence that it ever had in the life of the glossina the importance attributed to the water-crow of the banks of the Victoria Nyanza.

Use of a Viscid Paste to trap the Fly.

When the Correia Mendes Mission arrived in Principe in 1907, it found in use the method of catching flies by means of dark-coloured cloths smeared with viscus and placed on the backs of the serviçaes at work on the cutting of grass; its inventor was Senhor Bulhões

Maldonado, then manager of the Roça Sundy, who had been employing it since 1906. The number of flies (glossinas) caught on that estate alone, between April, 1906, and the end of 1907, was 133,778.

According to the observations of that Mission, the results of the use of this process were truly encouraging: two men wearing sticky cloths quickly made many infested places passable, and took a collection of 1,500 to 2,000 insects in the first days, the number falling to 20 at the end of a week's work.

The laws passed for fighting the epidemic gave official sanction and force to the process, making its adoption compulsory in every property. It was intended at first that every serviçal should wear on his person a cloth of this kind, besides clothing of lighter colour, with a cap and flap to cover the nape of the neck; but when, later on, it was found impracticable to enforce this measure to the full extent, the number of sticky cloths to be worn was reduced to one-tenth of the gang.

One of the difficulties in carrying out the measure in its entirety was the incumbrance which such an attire, combined with the sticky cloth, caused to the movements of the wearer, and the perspiration it checked when the wearer was working hard, thus tiring him rapidly and compelling him to fling it off. Besides which, the gluey matter had to be renewed daily, and as a fresh cloth every day would have cost an impossible sum in the long-run, it resulted in the addition of a fresh layer of the viscus day by day, until the weight of the cloth itself mounted to 3 or 4 kilogrammes.

Another drawback to the method was this: the wearers of these sticky cloths had to penetrate into the lands not yet cleared of vegetation, and in the course of their work would soon find the viscus covered by a layer of leaves adhering to it to such an extent that the fly could not find a spot anywhere upon it to stick to.

The only way out of the difficulty was to assign to the exclusive duty of fly-catching a certain number of serviçaes, chosen from those who were nicknamed *caranguejos* (crabs) because they were weaker than the rest. The wearers of cloths were scattered round about each relay of workers, occupying preferably the cleared bits and the places already freed from grass, whither the flies betook themselves, driven out of the forest by the shaking of the branches and the felling of the trees. A certain number were also sent into the places most frequented by the flies, such as the shady valleys, the neighbourhood of the streams,

Fig. 47 —Members of Fly-Catching Establishment, in Official Uniform.

rivulets, and swamps, and directed to wander slowly through them in all directions. They were grouped two by two, each being charged with the task of removing from his mate's cloth the leaves that chanced to adhere to it.

At night, on return to camp, the flies caught in the stickiness were counted, then taken off with the outside layer of viscus, and burned. At the beginning of the campaign there were days in which a single cloth contained as many as 500 glossinas, a fact verified by the health officer by actual counting. During the years 1911, 1912, and 1913 the total number of glossinas caught throughout the island by this process was 469,311, the average daily strength of the serviçal gangs employed on this duty in 1912 and 1913 being 141.

As the glossinas, attracted probably by the smell of the parts of the body left uncovered, often tried to sting the serviçal in front, the men employed on this work had instructions to make a note of this, and to drive them gently off by flicking them with a switch or twig of a tree, so that they should fly round to the man's back and get caught on the viscous cloth.

So long as the viscus was of good quality, the flies rarely managed to get free once caught, and when they did they were of no further service for mischief, as their feet and wings were effectually clogged. The first preparation used by Senhor Bulhões Maldonado was of local manufacture, composed of palm-oil mixed with pine resin. Almost all the combinations tried had the defect of drying quickly in the open air and taking on a pasty consistence on which the insects could settle unharmed. In some roças the serviçaes brought out with them a supply of fresh viscus with which they had to paint their cloths from time to time.

Of late years a viscus of English manufacture has been almost exclusively used; one of the best kinds is that made by Tunbridge and Wright, Reading, England, supplied to the island by the Lisbon agent, A. Vincent, Largo de Camões, 19. The article in question, as supplied, is of the colour and consistency of honey, perhaps a little thicker, and very sticky; it does not smell of resin; what slight smell it has is that of linseed-oil. It is put up in tins of 5 kilogrammes, packed in cases containing ten tins, and costs, delivered in Principe, from 1 dollar to 1·20 dollar (Portuguese currency). One tin of 5 kilogrammes is enough to smear from thirty to forty new cloths, or to refresh the surface of eighty used ones.

The viscus of this brand as a rule retains the necessary degree of fluidity; but in some of the consignments of other brands it was found necessary to add a certain proportion of palm-oil, heated, so as to get the desired consistency.

On rainy days a precipitation of the resinous principle appeared to take place on the surface, which turned white and impaired the activity of the layer to a certain extent. To avoid this drawback, the men were ordered to take off the cloths when it rained and to fold them with the sticky side in and put them away from the wet. After the shower they were directed to light a fire and warm the cloths at it before resuming the wear of them.

Under the sun's rays the viscus of the cloths melts and drips a little, but there always remains enough on the fabric to serve for the whole working day.

TABLE IV.—STATEMENT OF GLOSSINAS CAUGHT IN THE ISLAND OF PRINCIPE BY MEANS OF VISCOUS CLOTHS, FROM 1911 TO 1914, SHOWING AVERAGE DAILY STRENGTH OF THE SERVIÇAL FORCE ENGAGED.

Months.	1911.		1912.		1913.		1914.	
	Glossinas caught.	Men engaged.	Glossinas caught.	Men engaged.	Glossinas caught.	Men engaged.	Glossinas caught.	Men engaged.
January ..	17,705	—	29,953	—	21,434	139	19	171
February ..	14,705	—	18,025	—	11,865	139	10	173
March	14,005	—	12,885	—	9,450	139	4	173
April	13,705	—	10,175	—	6,000	139	1	197
May	14,000	—	7,907	—	4,200	139	—	197
June	18,000	—	9,771	—	3,158	139	—	197
July	19,001	—	13,036	—	2,768	139	—	197
August ..	10,600	—	16,301	139	2,934	139	—	197
September ..	14,175	—	18,850	139	2,700	139	—	—
October ..	13,937	—	15,973	139	2,311	139	—	—
November ..	23,506	—	22,450	139	1,368	163	—	—
December ..	30,200	—	22,000	139	134	163	—	—
Totals ..	203,629	—	197,325		68,322		34	

The cloths used by the brigade were made up of two layers of black serge, sewn one to the other, with a lining of canvas. The usual size of the garment was 40 by 50 centimetres. These cloths were not placed directly upon the clothing of the serviçal, but on a bit of linen a little bigger than the sticky cloth. Both pieces, fastened

one to the other, were hung from the shoulders by two tapes, one on either side, tied together in front, and were also fixed to the belt by two others joined to the edge of the cloth.

The fixed cloths, placed in the favourite haunts of the glossinas, gave some results at first, so long as the fly abounded; at that stage it was enough to rub some of the sticky stuff on the tops of the stones lying on the banks of the brooks, to catch flies thereby. But more than five or six flies were never caught on the fixed cloths, and as soon as they began to become scanty, the method proved quite profitless.

Measures applicable to Domestic Animals.

The provisions of the law relating to the animals used in agricultural work, to which we have already referred, aimed essentially at the following three objects:

1. To prevent these, as far as possible, from affording sustenance to the glossina.

2. To protect them from infection through the bite of the fly.

3. To prevent both the animals locally infected and imported cases from becoming the source of permanent infection in the island.

To attain the first of these objects, it was made compulsory to cover all the openings of stables and cow-houses with gauze wire netting, and later on, in July, 1912, the subsidiary notification giving effect to the decree of April 17 prescribed thirty minutes as the maximum period allowed for animals to halt in the streets of the town. Protection by means of sticky cloths, covering the chest of the horses, mules, etc., and the yoke (neck and shoulders) of the cattle, was a measure found hardly practicable, and was never largely carried out.

As to dogs, these were to be kept in kennels protected by gauze wire netting all day, and only let out after sundown and during the night, the period of liberty sanctioned for them being from 7 p.m. to 5 a.m.

Preventive injections of atoxyl, in doses from 6 to 8 grammes to follow each sting, in conformity with the second of the above items, has always, as may well be understood, been a measure very limited in its application. The prophylactic measure most generally employed in the case of infected animals has been their slaughter pure and simple. The common process of search for parasites in the blood has always been, as in the case of human beings, that of thick preparations, hæmolyzed by the Ross-Ruge liquid, washed after in methylated

spirit, and finally coloured by the Leishman stain. As a rule two preparations were made for each animal, the blood being taken at different hours and on successive days, so as to obviate somewhat the hourly and daily variations in frequency of the parasites in the peripheral circulation.

The number of examinations made of domestic animals since the beginning of the campaign, including horses, mules, donkeys, oxen, sheep, goats, and dogs, and their respective results, will be found in the table which follows.

Table V.—Domestic Animals examined, by Periods, with Respective Results, from 1911 to 1914.

Period of Examination.	*Trypanosome Carriers.*	*Filaria Carriers.*
March, 1911, to July, 1912	17	2
August, 1912, to May, 1913	206	40
October, 1913, to August, 1914	446	11

By this process all existing animals in the island were submitted to examination three times, irrespective of the examinations made of imported animals on their arrival in the island.

Before slaughter was made the fixed rule for all animals recognized as carriers of trypanosomes, a provision which the sanitary laws had placed within the reach of the health officer, it was proposed that they should undergo a rigorous treatment by means of atoxyl, in the hope thus to obtain a sterilization of their blood sufficient to make them harmless. The experiments in this direction made in 1912 by Bruto da Costa, over a series of 19 infected animals (2 horses, 7 mules, 2 donkeys, and 8 oxen), apparently carriers of parasites of the type *congolense*, by employing double injections at forty-eight-hour intervals in partial doses raised to a maximum of 30 grammes of the drug per injection, and involving a total expenditure of from 120 to 224 grammes in the course of from four to six months, showed the utter uselessness of such a process, for in the long-run these infected animals had to be systematically slaughtered. The number of animals killed on this account, from August, 1912, to May, 1913, was 2 horses, 7 mules, 15 oxen, 2 donkeys, 12 goats, and 1 dog, and between October, 1913, and August, 1914, 7 oxen and 1 mule.

From the examinations held on the landing of imported animals, upon the results of which depended the authorization for their internment in the island, it was very frequently found that the cattle arriving from Southern Angola were infected with the *congolense*, and lately there appeared likewise in the sheep and goats from that region some cases of infection by a trypanosome of the *Cazalboui* family, classified by us as belonging to the species *Trypanosoma uniforme*.

In the animals coming from Cabo Verde no case of hematic infection was ever discovered, although it appears that many of those oxen were sprung from stock of the Guinea coast, afterwards naturalized in the island colony; it happened that after a short stay on the island they showed signs of infection, and this leads one to suppose that there may have been some imported cases among them.

Measures applicable to Human Beings.

The discovery of infected cases among the inhabitants of the island was generally made by means of thick preparations, according to the technique above described; the search for parasites in the cerebro-spinal fluid was specially employed with the object of judging of the effects of treatment and of deciding as to the repatriation of old infected cases. Whenever possible, the juice of the swollen ganglions was examined, and some examinations of blood by centrifugation were also made.

From 1911 to 1914 the total number of examinations by means of thick preparations among the population of the island was 11,338. In this way 268 cases of trypanosomiasis were diagnosed, 923 of filariasis (*Filaria perstans*), and 710 of malarial infection (in the great majority of cases *Plasmodium præcox* or *falciparum*); from November, 1913, to June, 1914, 176 lumbar punctures were made in old cases, and trypanosomes were found inside the arachnoid canal in 16 of these.

During the whole period of the Mission's labours, a revision of almost the entire population of the island was made at three different seasons: from March, 1911, to July, 1912 (3,013 examinations), from August, 1912, to May, 1913 (3,932 examinations), and from October, 1913, to August, 1914 (4,333 examinations).

Besides these systematic examinations, all cases clinically suspected were at once submitted to a microscopic test of the blood, and, when possible, of the ganglionic juice as well.

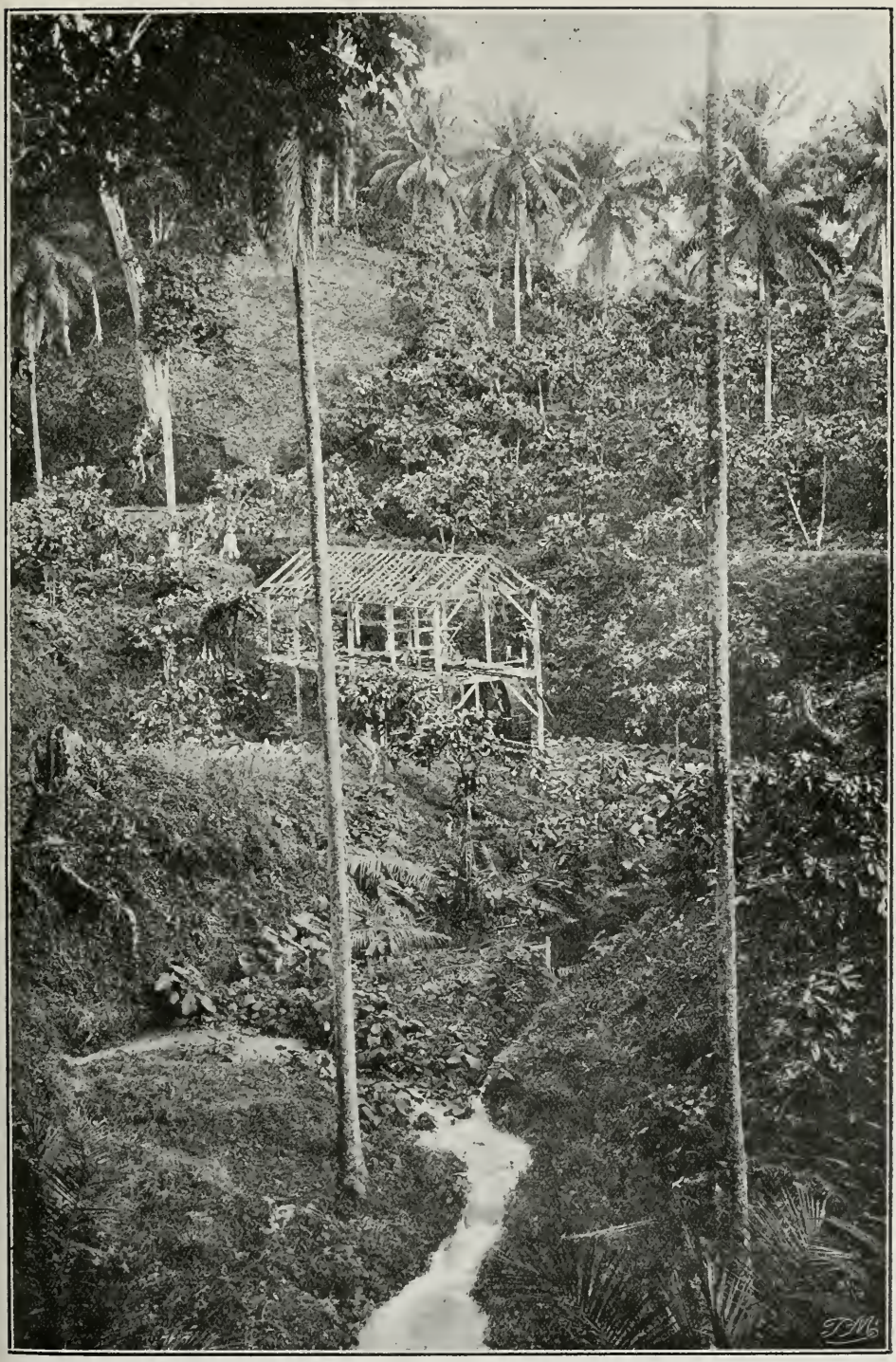


Fig. 48.—Drainage Work on Swamp on Roça Montalegre.

When diagnosed as a case of infection, the patient was isolated at once, sometimes on the property to which he belonged, when there was a hospital or a suitable house for his isolation, at other times in the State hospital, where this class of patient only paid a reduced rate, 50 per cent. under the established charge for treatment, as provided by the local notification of June 22, 1912. The sick man was at once put under atoxyl treatment in double injections of 0·6 gramme at forty-eight-hour intervals, every ten or fifteen days, spread over a period of at least four months, neither his discharge nor his release from isolation being given without repeated negative examinations of his blood. At the end of the campaign, when the glossinas had become rare and might be regarded as banished from the headquarters of the estates, isolation in the enclosure was changed into a prohibition against going beyond the limits of the property.

After their discharge, these people continued to be under medical supervision, and were periodically submitted to new examinations and to atoxyl treatment, according to the orders issued by the medical officer of the zone in which they were; meanwhile it was forbidden to the employer to use them in fly-catching, or in any other work entailing their going through the more infested tracts. This rule was extended to the case of all the former patients, even if in good health, and whose blood had long given negative results on examination.

It was forbidden to administer atoxyl to clinically suspected cases without microscopic confirmation, until the medical officer should see fit to give it, but these patients were also restricted to light work, and not allowed to enter places known to be haunted by the fly.

To make the vigilance of the sanitary authorities possible and efficacious as regarded the mode of carrying out the rules governing the carriers of infection, all the planters were obliged to keep up a book in a prescribed form, recording the names and origin of the persons attacked, date and manner of recognition of the infection, periods of treatment and its results, examinations to which they had been submitted, and any other data bearing on the history of the case. By means of this book the doctor of the zone could follow closely the advance of the disease in the patient, and inform himself at any time of his condition and of the kind of work that was being allotted to him.

To prevent as far as possible the entry into the island of fresh cases, thus increasing the number of sources of infection, no Angolan serviçaes have been allowed to be brought to Principe since 1911. At

Fig. 49.—Swamp at Praia da Lapa, Roça Porto Real, reclaimed with Stone and Sand.

Fig. 50.—Sanitation Work on Dumú Stream near Tronco, Roça Sundy.

Fig 51.—Hospital: Roça Sundy

the end of 1913 an attempt was made to bring men from San Salvador do Congo, and 37 men from that region arrived accordingly. These were submitted on arrival to a rigorous examination, their blood, collected from a vein, being systematically examined and submitted to fractionated centrifugation, and various ganglionic punctures made; three infected cases were thus discovered, and a fourth, classified as suspicious, some weeks later showed trypanosomes in the juice of the cervical ganglia. All these infected cases were repatriated by the first steamer after having received some injections of atoxyl.

As a general rule all the serviçaes who come into the island are put under a rigid clinical examination, and a microscopic examination of the blood of all suspected cases is made at the same time; only after these tests have been applied can the men be sent to their employers.

The repatriation of those who had completed their contracts was always preceded by a similar test, the Curator not permitting their embarkation until after the sanitary authorities had expressed their opinion. From October, 1913, to July, 1914, alone, the number of examinations of blood made with this end was 680, of whom 258 were Angolans, and 422 Caboverdeans; in 41 of the examinees *Filaria perstans* was found, and in 15 hematozoa.

As to the old cases, their repatriation was only permitted after rigorous clinical and microscopic examinations; once the result was such as to lead one to expect a possible cure, the Mission considered that there was no reason to oppose the wish that the majority of these people evinced to return to their own country.

But as the Mission had meanwhile of late received strong injunctions respecting the repatriation of serviçaes, it resolved to keep back all authorizations to this end until the very important question could be better studied.

In November, 1913, there were in the island of Principe 228 persons with a record of sleeping sickness, of whom a small number were recent cases, the greater number being old, and many of them only clinically diagnosed. Others were among the diagnoses made by the Correia Mendes Mission in 1908.

It was then proposed to segregate all these in camps established under the provisions of the decree of April 17, but which had never been started, and to this end the necessary intimations were made to the planters after the matter had been before the Sleeping Sickness Com-

Fig 52.—Right Bank of River Banzú, improved and cleaned up by Means of Cuttings: Roça Porto Real

mission and the sites had been selected for those camps. By this time the early disappearance of the glossina had been foreseen, and it was the intention of the Mission to try to reduce the value of all the pretexts which, when the island should in due season be officially declared free from infection, might be adduced to belittle the significance of the fact, and one of these would be the presence of a great number of sleeping sickness cases at liberty.

Before, however, proceeding to set up segregation camps, one of which was to have been the island of Bom-Bom, to the north, the other the peninsula of Focinho do Cão, to the west, all the individuals remaining on the lists of patients in the various estates were inspected, and it was found that the majority among them displayed a normal aspect, without clinical manifestations, the microscopic examination of their blood having for long failed to reveal the presence of parasites, and the men themselves having for months and years performed all customary duties on the estates, even the hardest.

The Mission chose, from these old patients without visible disease, 176 men, and it was arranged that all these should be interned by batches in the Government hospital so as to undergo the examinations considered necessary by the Mission in order to allow of a certificate as to their true condition. The subject was duly discussed, and it was agreed that all who satisfied the following requirements might, without appreciable inconvenience, be repatriated:

1. Absence of parasites in the cerebro-spinal fluid.
2. Rare or scanty cellular elements in that organic medium (sediment).
3. Absence of parasites from the blood, after search by thick preparations.
4. Good or fair general health.
5. Date of diagnosis anterior to 1913.
6. Period since last atoxyl injection exceeding four months.

Seventy-eight of the persons examined satisfied these requirements, and the Mission decided that it ought not to oppose their repatriation, which was at once carried into effect. Of these, 66 were natives of Angola, and 12 of Cabo Verde; the diagnosis of 38 of them, almost the half, went back to 1908, and of 16 to 1909, the remainder being between 1910 and 1912.

A second group of 43 serviçaes who showed some more cellular elements in the cerebro-spinal fluid and had broken off their treatment

Fig. 53.—Hospital on Eastern Section of Roça Porto Real.

by atoxyl less than four months before, although without any other morbid symptoms whatever, were kept under observation for four months longer, and as at the end of that time their condition remained unchanged, and they did not show parasites in any of the organic media, notwithstanding the cessation of atoxyl treatment, the Mission decided to let them also be repatriated.

The 55 who remained, whether through their general state of health, or through their showing parasites in the cerebro-spinal fluid, or, again, by the large number of cellular elements contained therein, had been included in the list of infected persons who could not leave the island, were condemned to pass the rest of their days in it, at the expense of their respective masters.

With the departure of these old cases, and with those who died up to the end of 1913 and in the first half-year of 1914, the number of sufferers from the disease in the island continued to fall from November, 1913, onwards; in January there were 193, and at the end of June, 1914, 38 only. Of these the whole were interned in the State hospital on the 30th of this month, as the planters had not complied with the order requiring them to set up segregation camps.

Preventive injections of atoxyl after sting by the glossina, which were made compulsory by law, came to have a more current employment in the island than was at first expected. Thanks to the propaganda made among the serviçaes, and to the example of the Europeans, the natives, especially those from Cabo Verde, reported having been stung quite freely as soon as it happened, and came in voluntarily for preventive treatment without showing the least repugnance to the operation; indeed, they trusted absolutely in its efficacy.

On account of the reaction usually following hypodermic injection of atoxyl, employers as a rule gave their servants a day's rest after the operation, and as the first injection had to be repeated forty-eight hours later, this gave them another day off; an additional inducement, according to their way of thinking, to promptitude in applying for this prophylactic.

On many estates no special register was maintained of preventive injections administered, so that the number, 372, furnished to the health office in 1912 and 1913, which, by the way, did not include those of the serviçaes of the official brigade, who were constantly being treated thus, must have been a serious understatement of the real number of persons who received this protection from the fly during the period in question.

Cost of the Chief Measures of Sanitation and Prophylaxis.

Both the State and local agriculturists contributed their share in the campaign for the extinction of sleeping sickness from Principe; the latter in the form of a strong labour-force, of material for sanitary defence, of curative and prophylactic treatment for those infected, and of the sacrifice of domestic animals shown to be carriers of the trypanosome. The State, on the other hand, maintained the establishments of the official brigade, including two European overseers, and the Medical Mission, adding to the latter as assistants two subordinates, and at the same time providing instruments and some sanitary material.

In round numbers, the expenditure incurred from March, 1911, up to June 30, 1914, was, in escudos (Portuguese dollars) 156,982.27, divided into shares between the State and the planters as follows:

	Dollars.
Total cost to planters of the island	84,032.75
Total cost to State, including medical mission and official brigade	72,949.52
Total	156,982.27

Expenses borne by the Planters.

In working out the expenditure incurred by private individuals, discrimination has to be made between the wages of labourers engaged in sanitating the lands, the wages of those detailed for the hunting down of the fly, the cost of the viscus supplied to these, of the mechanical appliances for the protection of dwellings and stables, etc., of the atoxyl consumed both therapeutically and in prophylaxis, and the value of the domestic animals slaughtered as carriers of the disease; the apportionment of these different items is as follows:

	Dollars.
Work done in the field (wages of labourers employed in cleaning up, grass-cutting and weeding, draining, reclaiming swamps, and felling	50,210.60
Wages of men detailed as fly-catchers	12,500.00
Viscus for trapping the fly	2,530.02
Mechanical protection of dwellings, stables, and cattle-sheds ..	4,500.00
Cost of atoxyl	2,723.37
Damage through slaughter of infected animals	11,568.76
Total	84,032.75

Fig. 54.—Drainage Works on Plantations on Bank of Rio Papagaio: Roça Bella Vista.

In the first item of those stated above are included the accounts paid to the brigade by planters in return for its services on their lands, adjusted up to June 30 last; and as in some of the notes submitted by the managers of estates the wages paid to the fly-catchers was not shown separately, we have set this charge down as five times the value of the viscus, this being the average proportion as judged by data obtained from different estates. Under mechanical protection of the dwellings we have included the cost of gauze wire netting, locks, springs, sockets, frames, and the labour required for fixing them; in the estimate of damage through slaughter of infected animals we have set down the oxen at only half of their value, seeing that their flesh was either sold or turned to account in the rationing of the labour establishments.

Expenses falling upon the State.

The exact account of the allotments expended by the State up to June 30, the total of which represents the burden falling upon the provincial budget in respect of services towards the extinction of the epidemic, is as follows:

	Dollars.
Wages and rations for the establishments of the brigade, including pay of two European overseers	55,328.53
Miscellaneous expenditure, including purchase of tools and other utensils	1,855.45
Increased expenditure for doctors for the Mission, and bounty for two hospital assistants	14,765.54
Purchase of viscus	600.00
Purchase of atoxyl	400.00
Total	72,949.52

Total Expenditure of the Campaign.

Adding together the planters' and the State expenditure under the various heads shown, we arrive at the following figures as those of the cost of the principal branches of sanitary work undertaken up to the end of the first half-year of 1914:

	Dollars.
Works in the field	101,394.58
Mechanical defence of dwellings, stables, etc.	4,500.00
Fly-catching operations by means of viscus	21,630.02
Medical officers and hospital assistants	14,765.54
Animals sacrificed	11,568.76
Atoxyl, preventive and curative	3,123.37
Total	156,982.27

FIG. 55.—JOLA SWAMP, DRAINED AND CLEARED: ROCA SUNDY.

For the period from March, 1911, to June, 1914, the services towards extinction of the epidemic cost, approximately, 52,327.42 escudos per annum, a little more than half of which fell to the planters. Reckoning the area of the island benefited directly and indirectly by the operations, at 100 square kilometres, the cost of sanitation per annum and per square kilometre would be 520.27 escudos, or, say, 5.23 per annum per hectare.

Private individuals shared in this expenditure to the approximate extent of escudos 2.80 per annum per hectare, and this, if we take the average net production per planted hectare at from 25.00 to 50.00, was a sacrifice far less than at first was anticipated—almost insignificant, indeed, if we take into account the magnitude of the results obtained. It would be no exaggeration to reckon at 20 per cent. the increase in value of most of the properties in the island, through the improvement in their sanitary condition, and to count upon an increase at the same rate, in the near future, in their annual revenues, thus compensating for all the money spent on them.

The expenditure demanded for the upkeep of the completed sanitary works represents a future burden relatively small, as far as private persons are concerned; many of the lands thus improved will shortly be under cultivation, and will not require more than the ordinary planting expenditure, with the added advantage of their good bearing qualities. The non-productive lands and those in which forest clearing and the upkeep of drainage channels will have to be provided for, should not require, annually, more than one-tenth of the cost of the permanent work done, or, say, in round numbers, 2,500 to 3,000 escudos.

On its side, the State, by keeping permanently in the island a gang of thirty men under a European overseer, for the clearing and cleaning of the native lands and the carrying out of measures directed by the health officer, which private individuals cannot themselves carry out, and assigning a monthly fee of 50 dollars to each of the two medical officers doing duty in the island, in return for the special service of vigilance which should continue to be maintained here, in the terms of our recommendation, should expend, likewise in round numbers, some 5,000 escudos per annum.

The maintenance of prophylactic services, which everything indicates as not to be neglected, will thus entail a maximum annual burden of 8,000 Portuguese dollars.

PART III

RESULTS OF THE SANITARY CAMPAIGN

Disappearance of the Glossina from the Island—Principal Means by which this has been Effected.

Taking as the index to the frequency of the diptera in different parts of the island the results obtained by the mode of its capture by sticky cloths, which we may with justice call the Maldonado process, it will at once be seen, by studying Chart I., the readings of which correspond to the figures of Table IV. (p. 107), that it was only in the beginning of 1913 that, from the sudden and continued falling off in the collections month by month from then, the manifest tendency of the insect to disappear was observable.

During the years 1911 and 1912 there were sharp oscillations in the number of glossinas caught monthly, the curve first rising, then falling, with irregular leaps, but all the same showing a marked depression in 1912, between March and August, the *gravana* months, during which the glossina is much less abundant than in the rest of the year. But it is necessary to bear in mind that the collection of the fly up to August, 1912, was as a rule irregularly carried out, and that the data furnished by the planters to the health officer often left much to be desired in the matter of truthfulness.

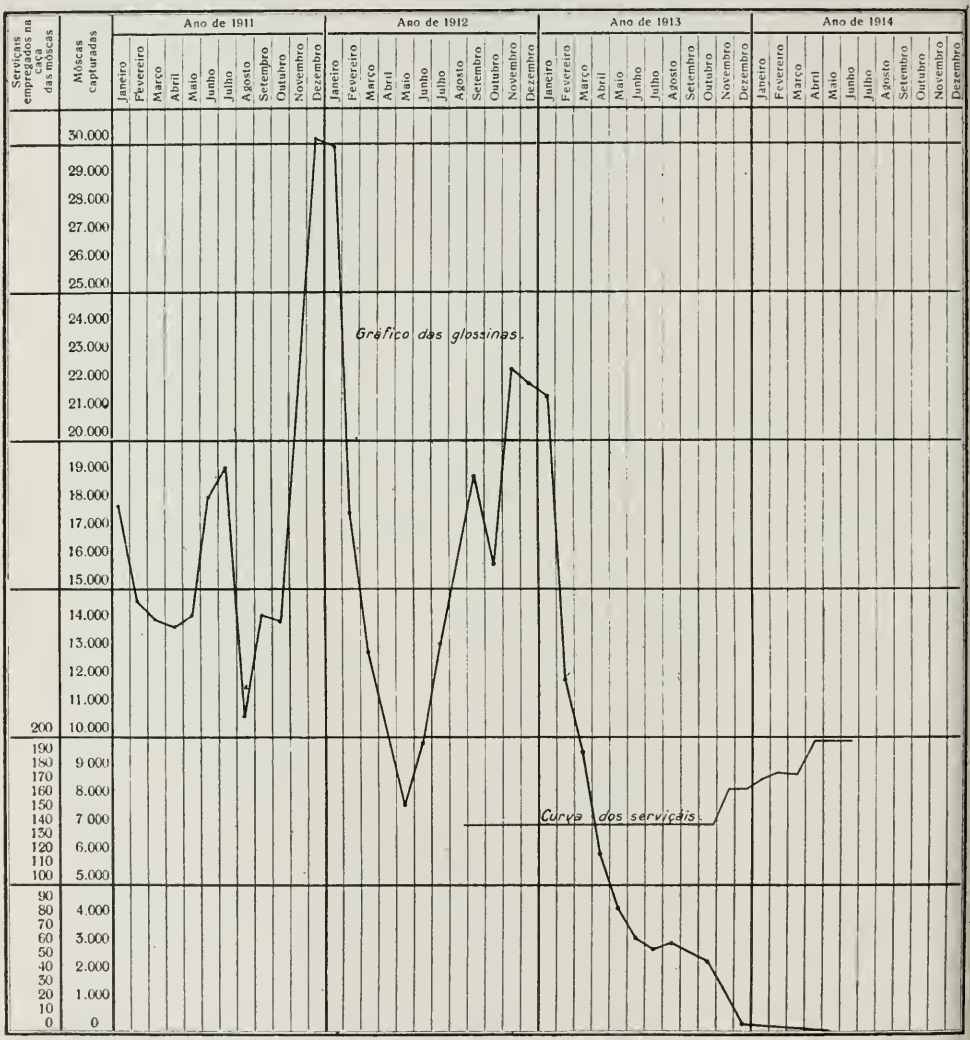
Thus, what has chiefly to be noted in the chart of the glossinas, as regards fly-catching all over the island, is the rise of the curve in the second half-year of 1912, a wavering between November of that year and January of 1913, a sudden and prolonged fall thenceforward until June, a second stop, this time on a lower level, between June and September, and a further fall to follow, only stopping at zero in respect of the insect in April, 1914, and this notwithstanding an increase of the fly-catching establishments from October, 1913.

For all its uncertainty and the contingency of the data it embodies

Fig. 56.—Dependencia Anselmo de Andrade, Roça Porto Real, near Lapa Beach: an old Focus of Glossinas now cleared.

CHART I.

NUMBER OF GLOSSINAS CAUGHT MONTH BY MONTH IN THE ISLAND OF PRINCIPE DURING THE YEARS 1911, 1912, 1913, AND 1914.



Serviçais empregados na caça das môscas = Serviçaes employed in fly-catching.
Môscas capturadas = Flies caught. *Gráfico das glossinas* = Curve of the glossina.
Curva dos serviçais = Curve of the serviçal.

FIG. 57.—SITE OF FORMER SWAMP OF PRAIA CAIXÃO AT MOUTH OF RIO BANZÚ, NOW COMPLETELY DRY: ROÇA PORTO REAL.

for the daily collections by means of the sticky cloths depended on factors essentially variable, it is possible meanwhile to pick out with tolerable accuracy from this curve the different phases of the campaign for the sanitation of the island.

Up to the middle of 1912 it was the small proprietors almost exclusively who tried to comply with the law, at the same time that the operations of the brigade were limited to the north-east and east of the island, felling and cleaning the lands of the natives and of some abandoned properties.

From March, 1911, to June, 1912, the works of greater scope that were executed were the fellings of Roças Santa Victoria, Boa Esperança, Pro-Vaz (Aguiem), Campainha, Azeitona, and Montalvão, all in great *obos* (virgin forests), existing in the north and north-east of the island. Scrub jungles were cleared, brooks were freed from noxious vegetation, likewise the smaller swamps, but much more than half the island, including the two greatest roças—Sundy and Porto Real—and others smaller—such as Paciencia, Antracia (Santo Antonio), Santa Rita, Bella Vista, etc.—had yet to be taken in hand, and if the glossina was becoming rarer in many of the places that had received the benefit of treatment, their principal hotbeds of infection remained in full activity, constantly hampering the efficacy of the partial work done.

In Sundy some fellings had already been effected, such as at Tronco Oqué Daniel and Ponta do Iola, incomplete in general, and undertaken more for agricultural than for hygienic ends.

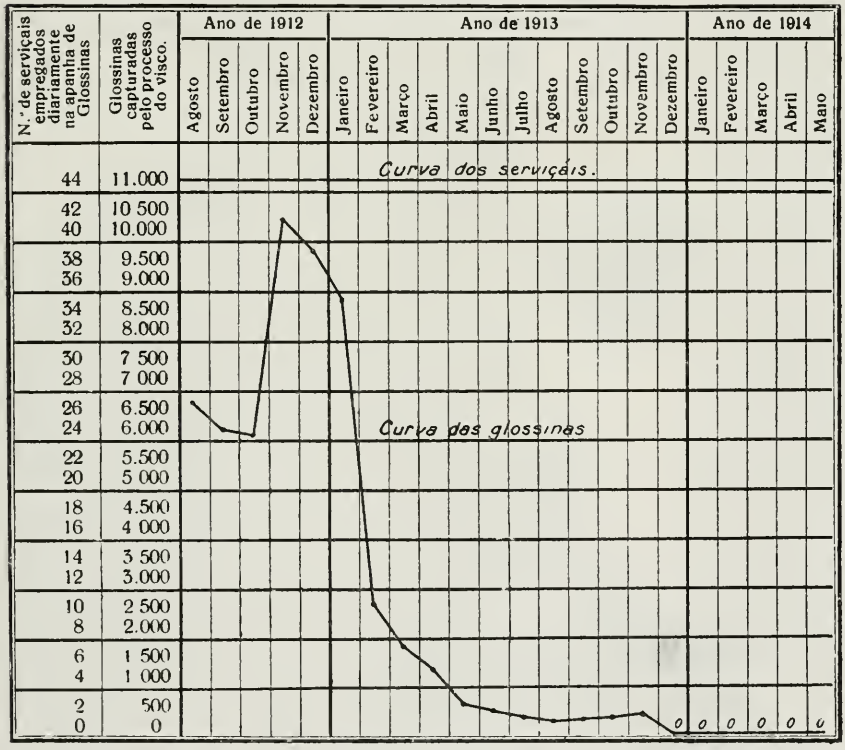
It was only from August, 1912, that a combined plan of operations, devised by the present manager, Senhor Manoel de Abreu, dealing with all the most infested spots in the vast estate of Porto Real, was undertaken. This plan included fellings, forest clearings, removal of scrub jungle, drainage and reclamation of swamps. All the works contemplated were put in hand almost simultaneously, the staff of the roça being split up for this purpose into different gangs, according to the sections into which the property is divided, each gang working within its allotted area.

At the beginning of 1913 the more important sanitary works in this roça, which occupies a third of the whole island, were concluded, their immediate effects being shown in a considerable diminution in the insect population therein, from January, 1913, onwards, the curve of the glossinas caught by means of viscus in this estate, as shown in Chart II., being very suggestive.

In certain parts of the estate the effects of the clearing of forests and *capoeirão*, as also the drying-up and clearing of the swamps, were almost instantaneous; thus, the work done on the swamp of the valley of Bacharel, where there used to be a tremendous nest of glossinas,

CHART II.

NUMBER OF GLOSSINAS CAUGHT ON ROÇA PORTO REAL FROM AUGUST, 1912, TO MAY, 1914.



N. de serviçáis empregados diariamente na apanha de glossinas = Serviçaes employed in fly-catching.

Glossinas capturadas pelo processo do visco = Flies caught by the process.

Curva dos serviçáis = Curve of the serviçaes.

Curva das glossinas = Curve of the glossinas.

begun in August, 1912, brought about the disappearance of the glossinas in the following month; in the Lapa swamp the last flies were seen in February, 1913; and at the mouth of the Rio Banzú they vanished the

Fig. 58.—Sanitation Works on Basin of Dumú: Roça Sundy.

month after. The last places where glossinas were found were the banks of the Rio Papagaio, in September, 1913, and of the Rio Bacharel, near some lands owned by natives, in November of the same year. From December onwards the sticky cloths drew blank, and the diptera was nevermore seen inside the plantation.

In the Roça Sundy, also a property vast in extent, embracing a great part of the swampy basin of the Dumú, full of breeding-grounds for the fly inside the mixed forests of cacao-trees and shade-trees, work was begun in December, 1912, upon the cleaning and freeing the current of the streams of Lama and Tronco; the felling of superabundant forest-growth and scrub in the *dependencias* of San Jeronymo, Oqué Daniel, Oqué Gaspar, and in various other places, was also undertaken. As usual, a rapid fall ensued in the number of glossinas caught wherever these measures were adopted.

In October, 1913, the monthly collection of flies in the estate was 982, the last being caught in the first quarter of 1914. It was necessary to make a large felling in the Boa Entrada forest (October, 1913), cut out some timber on the banks of the Lama, the Dumú, and the Boa Entrada, and on the left bank of the Izé, to free the flow and improve the bed of the two first-named streams, and to drain the adjoining lands, which were swampy (a work done mostly after January, 1914), before the insect gave up the fight and the roça could be considered free from it. The last of its tribe was caught in April, 1914, in the swamp of the Lama. Chart III. sums up the history of the banishment of the glossina from the Roça Sundy.

In the Roça Ribeira Izé, on the right bank of the stream of the same name, adjoining Sundy, the glossina persisted up to the month of March, 1914; the decisive works consisted in the drainage of a swamp in the middle of the plantations, beside the stream, and a similar work on the swamp of Furnas, near the sea.

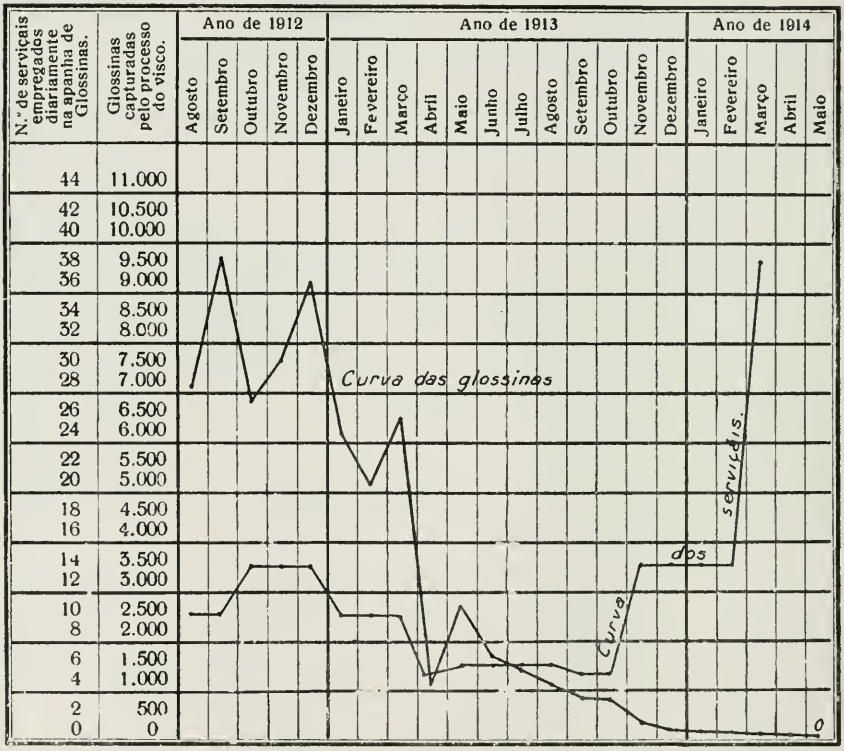
The delay in the completion of the work in the northern part of the island explains the dragging out of the curve of general fly-catching operations, towards its end, between the months of July, 1913, and April, 1914.

Starting from August, 1912, Chart I. shows with relative accuracy the phases followed by the sanitary campaign: first a rapid rise to October, coinciding with the direct attack upon the main foci, the glossinas falling then by thousands upon the fly-catching cloths sent out along with the labourers; then a maximum, between November

1912, and January 1913, corresponding to the climax of the campaign; and lastly, starting from the latter month, a headlong fall to July, the figure of glossinas caught decreasing from 21,500 a month to 3,000.

CHART III.

NUMBER OF GLOSSINAS CAUGHT ON ROÇA SUNDY FROM AUGUST, 1912, TO MAY, 1914.



N. de serviçais empregados diariamente na apanha de glossinas = Serviçaes employed in fly-catching.

Glossinas capturadas pelo processo do visco = Flies caught by the process.

Curva das glossinas = Curve of the glossinas.

Curva dos serviçais = Curve of the serviçaes.

Up to November the activity of the foci situated in the basin of the Dumú made itself felt in the northern part of the island, but it

then fell once for all, after the last redoubts of the insect, in the Roças Sundy and Ribeira Izé, had been stormed.

In the table which follows will be found a statement of all the glossinas caught in the island from January to April, 1914, not a single specimen having been found after the last-named month; from the indications furnished by the places where these flies were caught, the remnants of the island fly-population, it is shown that the last infected part of the whole was the northern area, and especially the Roça Sundy. By way of exception, there was found in March a single fly, in the central region, in lands belonging to a native which had not been cleaned.

TABLE VI.—LAST FLIES CAUGHT IN PRINCIPE, AND PLACES WHERE FOUND.

Places.	*Glossinas caught in* 1914.				
	Jan.	Feb.	March.	April.	Total.
Roça Sundy :					
Ribeira do Sundy	5	—	—	—	5
Praia Cornelio	2	3	—	—	5
Ribeira do Despique	1	—	—	—	1
Ribeira da Boa Entrada	1	—	—	—	1
Pedra Furada	3	—	—	—	3
Ribeira Lama	3	3	1	1	8
Praia da Ribeira Izé	—	1	—	—	1
Ribeira Gallinha	—	2	—	—	2
Roça Ribeira Izé :					
Right bank of Ribeira Izé	3	1	—	—	4
Furnas	—	—	1	—	1
Roça Paciencia :					
Praia das Burras	1	—	—	—	1
Comp. Unïo do Principe :					
Antracia or Teracia	—	—	1	—	1
Roça Bella Vista :					
Boundary of a native's land	—	—	1	—	1
Totals	19	10	4	1	34

The principal methods of attack employed against the glossina in the island were three in number: the clearing of the vegetation so as to let the direct rays of sunlight get at the soil and the air circulate

Fig. 59.—Felling near Praia Chumbo, on Roça Sundy.

Fig. 60.—Old Swamp on Banks of Volta, Roça Praia Inhame, now Dry

freely around the clearing; the drying of the swampy lands; and the extinction of the animals who used to lend themselves to the feeding of the insect.

The direct hunting of the insect by means of sticky cloths has never, by itself alone, proved a measure capable of reducing appreciably its numbers in the places it mostly frequents, and still less can it be relied on to effect its extinction from the island. The value of the MALDONADA process lies principally in the protection it affords to the workers in the more dangerous places, and in the index it affords, within limits, of course, to the frequency of the glossina in the particular area dealt with, and to the efficacy of the other measures put into practice against it. By itself, within practical limits, inasmuch as it is comparatively expensive on account of the great number of men it demands, it must be an offensive weapon of very slight value, and unlikely to give any very definite result.

Among the precautions taken, those whose effects manifested themselves earliest of all were the clearings of noxious vegetation, either in the form of forest fellings, of clearing woodlands to the ground, or of opening-up the *capoeirões*. As soon as the surface of the soil was laid open, and large gaps were made in its sumptuous covering of vegetation, the glossina, up to then abounding, at once made itself scarce, and vanished entirely in a very short time.

When the first preliminary work in the forests was undertaken, and the lianas, bushes, and slenderer trees were cut to allow the labourers to get at the trees to be felled, the fly began to disappear somewhat, but not completely so until a large clearing of the timber was made. In the inundated lands, beside the great swamps, on the banks of the streams flowing through deep valleys, the effects of the penetration of the sun's rays were, if anything, more sensible; but everything short of placing these streams, their bed, and their banks, freely in the open, was of little or no avail.

Of almost as great importance as the cutting-out of the vegetation was the extinction of the animals upon which the glossina most generally exercised its blood-sucking propensities. At the beginning of the task it was difficult to estimate the value of the slaughter and the pursuit of the wild pig, as it took place simultaneously with the clearing of the vegetation; later on, despite every vigilance and activity, the cleared lands became again covered with scrub (*capoeirão*) and jungle, forming in many of the former foci thickets favourable to insect life

But it was a matter of common observation that those places only became alive with glossinas when the wild pigs returned and regained their former dominion in them.

The almost complete extinction of wild pig and the very considerable diminution of stray dogs seem in themselves to account for the fact that the glossinas did not resume possession of their former breeding-grounds, in spite of the reconstitution, not always easy to prevent, of favouring shelters for them.

Progress of the Malady of Late Years.

Among the data which allow us to look more closely into the march of the epidemic of late years, the numbers representing the percentage of known infected persons to total population of the island at given periods are of particular interest; from these we will exclude the population of the Roça Infante D. Henrique, among which cases of local origin have never been found to exist.

In 1908, after the labours of the Correia Mendes Mission, the general mean of infected persons in the island, having in view the results of microscopic examinations, was 26·07 per cent. In May, 1911, the note of sleeping-sickness cases that the Mission then possessed gave as existing at the commencement of the present campaign 17·34 per cent. of sufferers in the population of the infected zones; in May, 1913, that percentage had fallen to 7·7. At the end of June of the current year (1914), a certain number of sick having been sent to the Colonial Hospital at Lisbon, after repatriation of a large number of old cases apparently cured and whose cures were of long standing, and the usual addition of fresh cases during the past year since last return having diminished considerably, the percentage of infected persons was found to have fallen to 0·66.

For the study of the distribution of the sickness in the island, the Medical Mission divided it up into six zones, the designations of which, the principal estates in them, and their respective population in June, 1914, are as follows:

Northern Zone.—Roças Sundy, Ribeira Izé, Santa Rita, Bom-Bom, Cascalheira and Aguiem; population, 908.

North-Eastern Zone.—Roças Praia Inhame, Sant' Anna, Futuro, Paciencia, and Belmonte; population 539.

Town Zone.—Native population of the island, Europeans living in the town of Santo Antonio, and the official brigade—total, 1,262.

West-Central Zone.—Roças Porto Real, Nova Cuba, Bella Vista, Saudade, Santo Antonio, and Montalegre; population, 1,420.

Eastern Zone.—Roças Abbade, Santo-Christo, Nova Estrella, Terreiro Velho, and San João; population, 772.

Southern Zone.—Roça Infante D. Henrique, with 568 inhabitants.

In the following table, and in Chart IV., relating to it, are shewn both the degree of infection of each of the zones at different periods, and the rapid downward tendency of the number of sufferers in all of them under the influence of the sanitary measures carried out from 1911 onwards.

Table VII.—Percentage of Infected Persons per Zone per Annum.

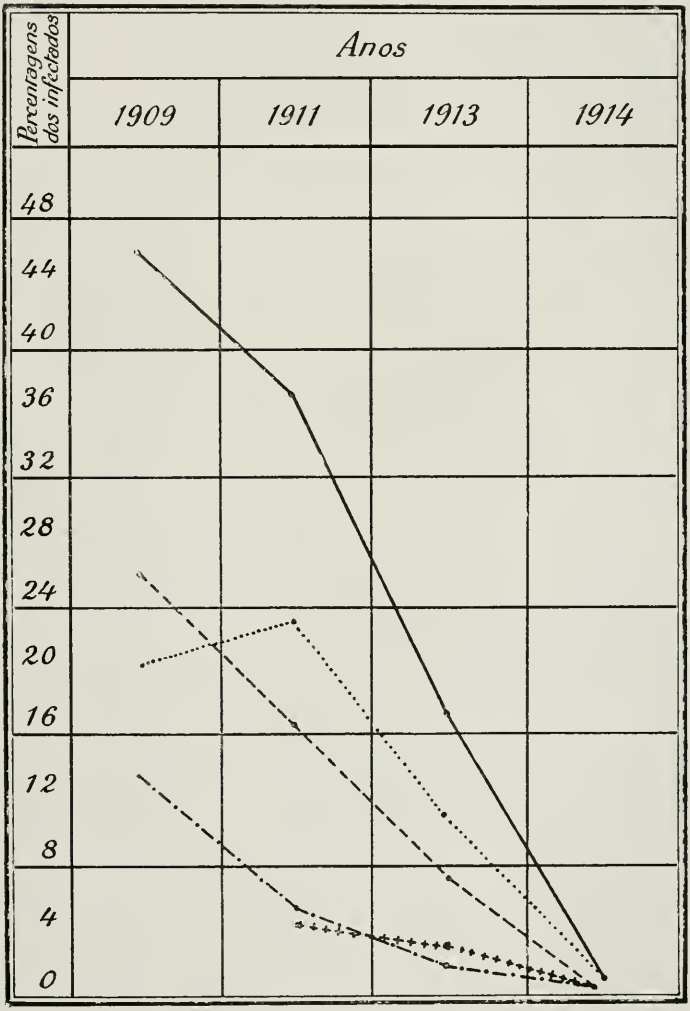
Zone.	1909.	1911.	1913.	1914.
Northern zone	45·8	36·8	17·1	1·0
North-eastern zone	25·8	16·2	7·3	0·3
Town zone	—	4·8	2·3	0·4
West-central zone	20·0	23·2	10·3	0·8
Eastern zone	12·7	5·7	1·5	0·2
Southern zone	—	—	0·1	—

The distribution of the disease in the island maintained a steady and notable parallel course to the degree of infestation of the lands. In the north of the island, then included in the northern, north-eastern, and that part of the west-central zone contiguous to the former focus of the Ribeiras Lama and Gallinha, the infection always weighed heaviest in the local nosology, seeing that it was there that the most important and least easily eradicated foci of glossinas had their abode. Now, in the eastern zone, belonging geographically to the central area, their predominance was less notable, their value being negligible in the south of the island, a zone free from the glossina. In the different zones, their positions, as regards the degree of invasion, kept among one another distances almost equivalent, with scarcely appreciable alterations, up to the end of the epidemic.

Another appreciation of the march of the epidemic is derived from the result of systematic examinations of the blood, in thick preparations, of all or the greater part of the population of the island, at

CHART IV.

PERCENTAGE CURVES OF INFECTED PERSONS BY ZONES IN FOUR DIFFERENT YEARS.



——— Curve of northern zone.
– – – – – – – ,, north-eastern zone.
..... ,, town zone.
– · – · – · – ,, west-central zone.
+ + + + + + + ,, eastern zone.

Percentagens dos infectados = Percentage of infected persons.

Fig. 61.—Part of Drainage Works on Swamp of Lama-Lama, Roça Praia Inhame.

different periods, starting from March, 1911. As we have said already, this systematic revision took place at three different seasons: March, 1911, to July, 1912; August, 1912, to May, 1913; and October, 1913, to July, 1914. The number of examinations held in each of these periods, the cases of trypanosomiasis discovered, and the respective percentages, are shown in the following table:

TABLE VIII.—EXAMINATIONS OF THE BLOOD OF THE POPULATION BY PERIODS, AND THEIR RESULTS.

Period.	*Number of Examinations made.*	*Number of Positive Cases.*	*Percentage of Infected to Persons examined.*
March, 1911, to July, 1912 ..	3,013	124	4·11
August, 1912, to May, 1913 ..	3,992	125	3·13
October, 1913, to July, 1914 ..	4,333	19	0·43

As might be expected from a disease of so long incubation, and in which the process of investigation followed does not always lead to the discovery of the parasite, the percentage of positive examinations only fell markedly from October, 1913, onwards, approximately six months after the great break in the frequency of the glossina in the island.

If we look at the percentages of the table above, not with reference to the number of persons examined, but to the mean total population of the island for the periods indicated, we shall find the figures to be 3·05, 2·7, and 0·37, which retain among themselves similar proportions.

Referring to the number of persons examined, the fall in the cases of infection discovered in each of the periods in question would be represented by the following figures:

100 76 10

If we go back to the figures of total population, the numbers indicative of the proportion of fresh cases would be:

100 88 12

Which ever way it be looked at, it is evident that the frequency of the recognizable infections by examination of blood in preparations fell, in the last period of the analyses, to one-tenth of what it was at

Fig. 62.—Mixed Swamp of Praia das Burras, Roça Paciencia, now Dry

the beginning of the sanitary campaign, and it was not expected that it could have been reduced to zero only a few months after the more perceptible results of the work done had manifested themselves.

For the better interpretation of the data above set forth, we must take into account the time of residence of the persons recognized as infected from October, 1913, onwards; the list which follows sums up by groups the stay in the locality, counted from the day of landing in the island to the date of diagnosis, of 19 carriers of trypanosomes recently diagnosed as such:

Persons recently recognized as infected, with less than six months' residence in the island			0
Ditto,	ditto,	with from six months' to one year's residence ..	1
Ditto,	ditto,	with from one year to two years' residence ..	1
Ditto,	ditto,	with from two to three years' residence	7
Ditto,	ditto,	with over three years' residence	10
		Total	19

None of these patients thus had a residence of less than six months in the island; among those who had more than three years, some reckoned six and seven years of consecutive residence.

On the strength of these data the Mission expressed, in its report of June, the opinion that as no infected person with less than six months' residence had up to then been discovered, the least period of residence of an infected serviçal at the January examination of 1914 being seven months, there was every reason to suppose that the island had ceased to offer conditions favourable to the propagation of the disease about that period, when the number of glossinas in existence, all told, could not have been more than a very few dozen.

In order thoroughly to clear up this point, in July all the serviçaes who had arrived in the island from January onwards were submitted to a rigorous clinical inspection, completed by blood examination, excluding, however, those who had already been resident. There were in the former category 205 natives, of whom 175 were Caboverdeans, 20 Angolans, and 10 natives of San Thomé (the last-named being members of the brigade). In none of these cases did either the clinical inspection of the microscopic examination lead to the discovery of infection, this being one more reason strongly in favour of the opinion expressed in June. Now, at the end of September, that opinion seems more than ever the true one.

Mortality in the Island during Recent Years.

In Chart V. are set forth the numbers relating to deaths in Principe for the last twelve years, as shown in Table I. on p. 3. It shows that up to the end of 1913 the fall in the general mortality of the island continued with geometrical regularity, sinking from the extraordinary level of 221 per mille in 1902 to 69 per mille in 1913, a rate which, though it cannot be regarded as very good, as it is still far short of the 26·84 per mille of the native mine-workers of the Transvaal in 1912 and the 10 per mille of the Panama canal negroes in the same year, nevertheless represents a very considerable advance in local health conditions, for in twelve years there has been a fall of no less than 68·8 in the death-rate, or, what comes to the same thing, in 1913 it has been reduced to 31·2 per cent. of what it was in 1902.

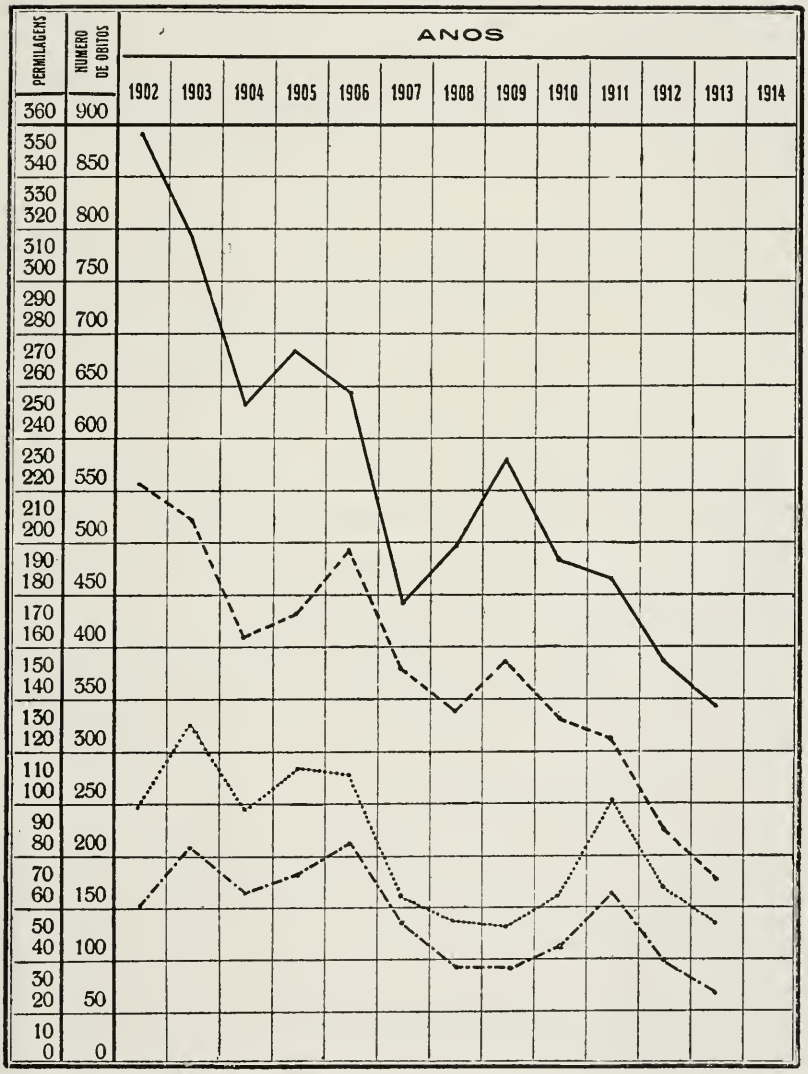
It is only from 1911 to now that explicit data are forthcoming as to the diseases causing those deaths. The number of deaths from sleeping sickness is meanwhile known with relative accuracy since 1902, and it is to be seen from them that in the last thirteen years the share of this infection in the general death-rate has varied from 53·17 per cent. (in 1911) to 27·6 per cent. (in 1902), and thus may be explained, partially at least, by the activity of the epidemic—the high figure of mortality shown in the statistics. The mean mortality due to trypanosomiasis in the last twelve years has been 37·4 per cent. of the total mortality, or a little more than one-third of the latter.

Once the epidemic, which even in the first six months of the current year was responsible for 43 deaths in a general total of 151, has disappeared, one of the most active of lethiferous causes will disappear along with it, and the time will not be far distant when the island can be regarded as one of the healthiest of equatorial agricultural colonies employing imported labour.

If we compare the curves of absolute general mortality and of mortality from trypanosomiasis, as well as the respective annual rates between 1902 and 1913 (Chart V.), it will be seen, with slight exceptions, that the law governing the fall of the first-named closely follows that of the variation of the second, and an idea may thus be gained of how much the latter has contributed to the high figures reached by the former. The highest figure of general mortality, in 1902, is equal to 2·59 times that of the lowest, in 1913; the maximum limit of

CHART V.

General Mortality, and Mortality through Sleeping Sickness in Principe, from 1902 to 1914.



——— Curve of general mortality, 1902-1914.
- - - - - - „ „ „ from sleeping sickness, 1902-1914.
..... Total mortality per mille to total population.
- . - . - . - „ „ „ from sleeping sickness to total population.

Permilagens = Per mille.
Numero de obitos = Number of deaths.

mortality from the disease, in 1903, is 2·43 times that of the respective minimum, in 1913.

Let us now see, taking the last three years, what have been the other pathological entities which have affected the high rate of mortality of the island.

Let us begin by giving prominence to the high death-rate contributed by children under ten years of age, which may be gathered from the figures which follow, showing deaths among adults and minors separately:

	Adults.	*Children.*	*Total.*
Deaths in 1911	411	61	472
„ 1912	309	77	386
„ 1913	276	68	344
Total	996	206	1,202

From this it will be seen that in the last triennial period infantile mortality by itself has been slightly less than one-fifth of the general mortality.

Breaking up the statistics of mortality into the different morbific categories composing it, we get Table IX. below:

TABLE IX.—ANNUAL MORTALITY, CLASSIFIED BY GROUPS OF DISEASES, FOR 1911, 1912, AND 1913.

Groups of Diseases.	*Years.*		
	1911.	1912.	1913.
Sleeping sickness	251	166	133
Affections malarious in origin	2	16	12
Intestinal helminthiases and others	39	40	45
Syphilis	1	3	8
Dysentery	3	3	8
Infecto-contagious diseases and general infections ..	69	37	26
Diseases of organs and systems not infectious	51	59	50
Constitutional diseases and poisonings	20	42	37
Diseases of traumatic origin	3	9	13
Unspecified diseases	33	11	12
Total	472	386	344

From the above table it will be seen that, after sleeping sickness, the maladies most prominent in the scale of mortality are those belonging to the following categories, arranged according to order of frequency:

1. Non-infectious diseases of organs and systems.
2. Infecto-contagious diseases and general infections.
3. Helminthiases, intestinal and other.
4. Constitutional diseases and poisonings.
5. Unspecified diseases.
6. Paludism and its sequelæ.

The percentages to general mortality corresponding to the maladies which during the last three years have shown themselves most deadly are set forth in the further table to follow:

TABLE X.—PERCENTAGE OF DEATHS FROM THE FOLLOWING DISEASES IN RELATION TO GENERAL MORTALITY.

Groups of Diseases.	*Years.*		
	1911.	1912.	1913.
Sleeping sickness	53·17	43·0	38·34
Diseases of organs and systems, unspecified	10·80	15·2	14·50
Infecto-contagious diseases and general infections ..	14·60	9·5	7·60
Helminthiases	8·00	8·2	13·00
Constitutional diseases and poisonings	4·20	10·9	10·80
Unspecified diseases	6·90	2·8	3·50
Paludism and its sequelæ	0·40	4·1	3·40

In the diseases of the organs and systems the lesions of the circulatory system (cerebral and pulmonary congestions, organic affections of the heart, etc.) predominate, showing 55 deaths in the triennial period; then follow those of the digestive system (enteritis, gastro-enteritis, diarrhœa, grave icterus, etc.), with 52 deaths; those of the respiratory system (bronchitis, broncho-pneumonia, pulmonary emphysema, etc.), with 25; and of the genito-urinary system, with 11 deaths in the triennium.

Among the infecto-contagious diseases pneumonia takes the first place, 43 deaths having been recorded during the triennium under this head; next follow tuberculosis and tetanus, with 29 and 30 deaths

respectively, and influenza, with 23; cerebro-spinal meningitis and carbuncle only show up sporadically, the former with 4 deaths and the latter with 1.

Under the category of helminthiases as causes of death, ankylostomiasis bulks largest, and is credited with having caused 97 deaths within the three years in question. Both in this island and in San Thomé intestinal worms contribute largely, not merely to general mortality, but also to the very high rate of invaliding among the wage-earning labourers.

Into the mortality due to constitutional diseases there enters principally congenital debility among the new-born and senile debility (the former showing 56 deaths in the triennium). From 1911 to 1913 the returns only give 3 fatal cases of beri-beri, a disease which we include in the designation of " poisonings " (*intoxicações*). The heading " Unspecified Diseases " relates generally to deaths among natives of the island unattended by a medical man.

Affections of malarial origin take the last place in the list of the more frequent causes of death; their lethal activity has totalled 30 deaths in three years, corresponding to 2·6 per cent. of the general mortality, and including in that figure a considerable number of Europeans. Paludism nevertheless does not fail to figure as a morbid entity of importance in the hygiene of the native population, for the cases of its manifestations are very frequent, and it may be taken that a loss of 10 per cent. of the working time of the men on the roças is due to this cause alone.

The general percentage of carriers of the hæmatozoa, ascertained by systematic examinations of the island population by the process of thick preparations of blood, was 4·7 per cent. in 1911-12, 7·2 per cent. in 1912-13, and 6·5 per cent. in 1913-14. At first no distinction was drawn between the serviçaes of Angola, of Cabo Verde, and the natives of the island, as regards the degree of malarial infection; but it is a matter of common observation that not only is there a greater frequency in the presence of the parasites in the blood of natives of Cabo Verde, but also a less degree of tolerance for them on the part of these, compared with other natives. The rise of the figure of hæmatozoa carriers of late years may be ascribed without fear of error to the increase in the floating population from that source, side by side with the reduction in the number of the Angolan serviçaes.

As regards infection by the *Filaria perstans*, verified by the same

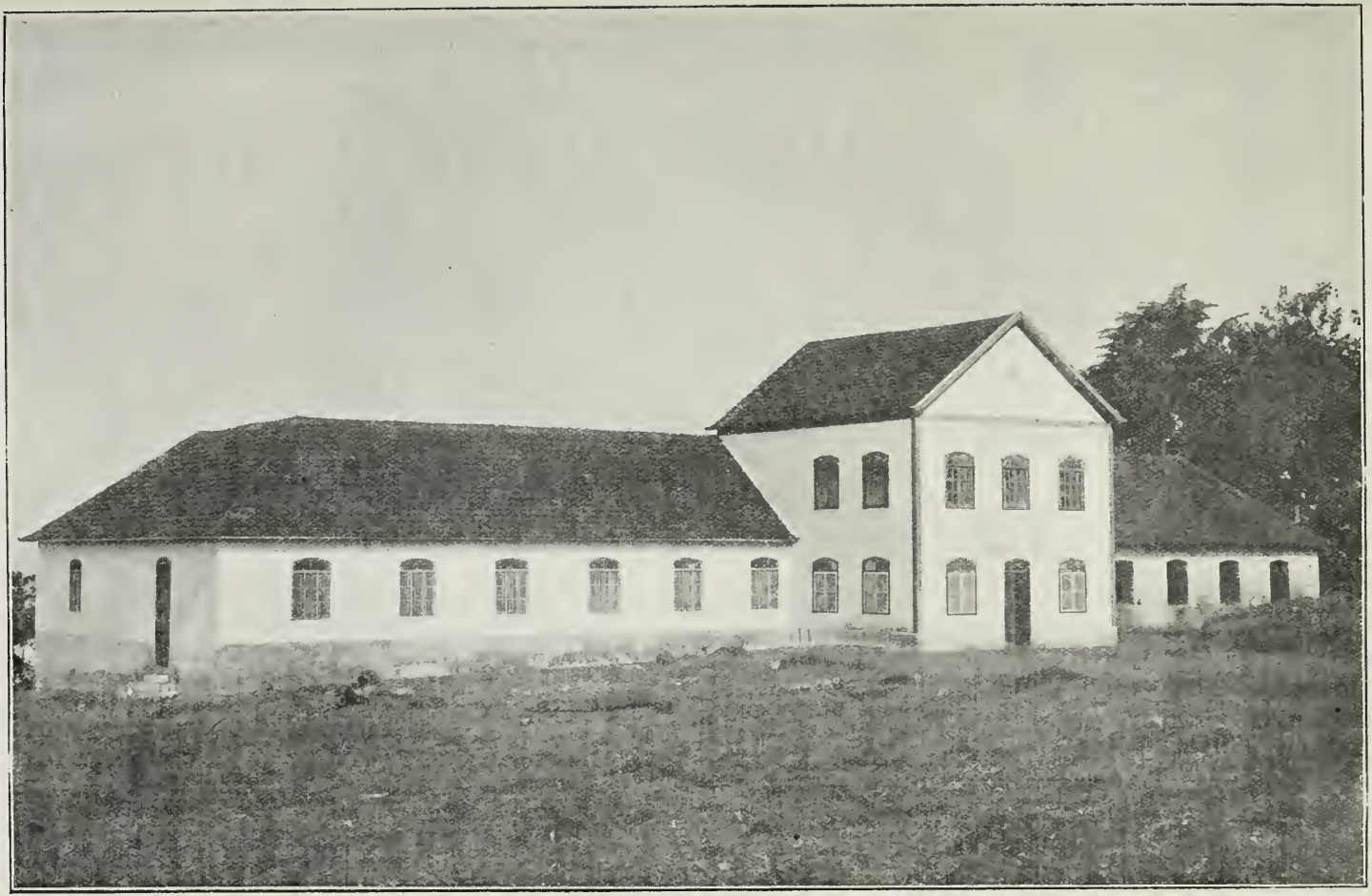


Fig. 63.—Hospital under Construction, Roça Porto Real West.

process, the proportions are inverted: the Angolans give 20 per cent., the Cabo Verde people 4·5 per cent., and the natives of the island 10·2 per cent.

Notwithstanding his high degree of malarial infection, the native of San Thiago, to whom exclusively relates what has here been said regarding the Caboverdean population, offers an accentuated resistance to the climate, and if malarial influences operate upon him as a frequent cause of morbid manifestations, they have but little effect, according to the common experience with coloured races, as a cause of death.

Compared with preceding years, the fall in the mortality of the island in the first half-year of 1914 was very marked; the number of deaths was 151, as against a mean of 200 in the first half-years of the three years that preceded it.

One of the most important reasons for this fall was the diminution of the mortality from sleeping sickness, which dropped to 43 deaths in that period, as against a mean of 93 in the three years which went before. Making abstractions of sleeping sickness, the remaining causes of death produced 108 fatalities, while the mean of the corresponding periods of the three past years has been 107.

So far, it will be seen that, though the diminution of sleeping-sickness mortality has been considerable, a similar improvement is not to be noted in respect of the remaining causes of death. But it cannot with justice be said that the general sanitary conditions of the island have ceased to progress; the fact merely translates the action of certain extraneous influences, among which figure the introduction into the island of Indian prisoners, and, latterly, the arrival of immigrants from Santo Antão, people of weak constitution and very scanty power of resistance, some of them already moribund when landed, and a great many dying in the first two months of their residence. These deaths weighed in the demographic balance without local health conditions entering into the equation in any manner whatever.

PART IV

SANITARY FUTURE OF THE ISLAND

Prophylactic Measures against Sleeping Sickness.

With the disappearance of the glossina from the island, the reduction, to a little over 30, of the cases of human trypanosomiasis in it, these cases being isolated in the State hospital under the direct supervision of the health officer, the cases of fresh infection being extremely rare, and all of them diagnosed among persons who arrived in the island before the second half-year of 1913, and with the former foci of the glossina improved out of existence by the methods described, the Mission regards its task as completed, and its plan of operations for the extinction of the epidemic crowned with success. The present position of affairs may thus be summarized: *Glossinas :* it can hardly be supposed that a single living specimen remains in the island. *Fresh recorded cases :* only cases inoculated previously, with a period of latency exceeding one year.

Nevertheless, something yet remains to be done. To fold one's arms and straightway to forget that Principe has been scourged for years together by an epidemic of so lamentable consequences would be illogical and but little creditable to one's intelligence. Having extinguished the conditions of propagation of the infection, everything unites to counsel the retention of what has cost so much in labour and in money: not to allow the lands of the island to lapse into their primitive state of neglect.

It is now five months since a single glossina has been found anywhere in the island, in spite of the vigilance that has unceasingly been maintained over all its former breeding-grounds. We have entered upon the rainy season, the temperature has risen, the spontaneous vegetation has sprung up with its customary exuberance in all directions, and the expectant attitude maintained by the Mission has

not yet had to be interrupted by the necessity for any active intervention.

Thus the presence of the Mission henceforth seems superfluous, and also of the full brigade of the island, a partial demobilization of its sanitary forces being indicated; likewise certain modifications in the defensive laws now in force.

The Medical Mission can at once be reduced to two practitioners, but it is indispensable that these should be chosen from among the four now on the island who have identified themselves personally with the work done and know in detail the regions forming the field of its labours. The strength of the brigade should be reduced to 60 men under a single European overseer.

After six more months of observation the Mission should be dissolved, the duties of sanitary supervision in this special respect being transferred to the two doctors whose turn it may be to serve in the island, the health officer retaining 30 permanent serviçaes and 1 European overseer under his orders.

As for the legislative provisions governing the case, the three enactments in force up to now—namely, the Decree of April 17, 1911, the Local Government Notification of June 22, 1912 (No. 208), and the Decree of August 17, 1912, should be modified so as to fit in with the new order of things, and consolidated into a single law.

The Mission has drafted a bill which it is thought will serve the purpose. That purpose consists chiefly in the maintenance of the sanitary conditions of the island, as far as sleeping sickness is concerned, at the level at which they now stand. A law of this nature must rest upon the following fundamentals:

1. *Human Beings.*—Not to admit into the island any natives from infected regions; not to allow patients actually suffering from the disease to leave the island unless the case of each offers a relative but stable guarantee of prospective cure; compulsory internment for all existing cases of sleeping sickness in the State isolation hospital; permanent medical supervision for all the inhabitants of the island; obligatory notification of all cases of human trypanosomiasis occurring in future.

2. *Animals.*—Not to permit the importation of animals from regions infested by the *tzetze* except for immediate slaughter; prohibition of all rearing of domestic animals in flocks or herds, except in the southern part of the island; total prohibition of pig-breeding in any part of the

Fig 64.—Paved Channel for draining Swamp on Beach of Roça Abbade.

island; restriction, by means of appropriate regulations, of the canine population of the island.

3. *Lands.*—Compulsory annual cleaning of all lands not under cultivation by the owners of them; periodical improvement of the beds of streams and swamps, and the upkeep of the various works executed by the present Mission; no *obó* (thick forest) to be allowed to reproduce itself under 200 metres of elevation; compulsory notification of the reappearance of the glossina in any part of the properties.

As we have said farther back, the maintenance of this vigilance and conservancy represents a burden of but comparatively small weight either upon the State or the individual; the former need not spend more than 5,000 dollars per annum upon it, and the share of the latter ought not to exceed 3,000 dollars, in compensation for which he will, as an agriculturist, reap the benefit in the enhanced cultural value of the lands thus treated.

General Sanitation—Rules to which Future Schemes for Sanitary Improvement should conform.

Although, properly speaking, not within the terms of our reference, especially as the Mission has now completed its functions, we will not close our report without recording an opinion as to the means by which, in practice, the mortality of the island may further be reduced. It is to-day much lower than it was ten or twelve years ago, but for a population mainly adult, with a predominant floating element, it is still very high.

To improve the death-rate, the first thing needful is a reduction in the numbers shown by the nosological tables, and every effort should be directed to this end. With the improvement of the health of the agricultural labouring population hygiene will be the gainer, as will also the island economy, upon which a heavy tribute is payable in the form of invaliding of its workers through disease of various kinds. The problem must ever be considered from the double point of view—of humanity and of finance—and rightly so, for in this way it will be easier to secure private co-operation, without which the most perfect of regulations and the most closely woven network of fines and penalties will prove worse than useless.

To each of the pathological heads already cited as weighing most heavily in the necrological charts of the island, there no doubt corre-

sponds a series of rules and recommendations which are to-day among the commonplaces of medical science, and by whose application, in theory at least, it is possible to take the field against the respective morbific agencies.

Meanwhile, instead of trying to settle what should be done in the case of each of the prevailing maladies of the region as a separate cause of mortality, and thus to restrict its field of action, we think it more useful to insist upon the modifications to be introduced into native local life conditions, especially those of the estate labourer, as a guarantee of improved hygiene and of reduced incidence of morbific causes.

Among the factors of individual and collective hygiene coming into play in native habits and mode of life on the island, the following deserve special mention: The dwellings of the serviçaes on the agricultural estates; their feeding; the disposal of dejecta; rules affecting their labour; alcoholism; medical attendance; paludism; local inspections previous to embarkation for the island; vaccination; infecto-contagious diseases of imported origin.

Housing of African Native Labourers.

The progress made in this direction of late years has been important. Some proprietors have submitted to very real sacrifices in order to provide dwellings, both for their contracted native labourers and for their European employés, such as they intend and believe to conform to indispensable requirements. There is still much to be done; but much has already been done, if we take into consideration the crisis through which the island has of late years been passing on account of sleeping sickness.

A notable and general lack of guidance is betrayed by the works that have been executed. The native lines constructed lately, though almost always built with the best of materials, as a rule follow some plan drawn up by the estate manager, and he, jealous of his independence, refrains from taking counsel about them with the Board of Labour and Emigration, or with the health officer.

The *sanzalas* of modern construction almost invariably partake of one essential defect—they are built in single blocks and thus form long barracks or dormitories, with, indeed, separation for the sexes, but otherwise compelling all the serviçaes of the estate or section to live

in common. In some of the older buildings, though these leave much to be desired in other respects, the system of division into compartments, each accommodating a limited number of individuals, is retained, though even here it sometimes happens that the partitions are incomplete; but to-day the barrack-room type is that which finds favour among the majority of the planters.

The plan to be recommended, when separate rooms for families cannot be provided, would be that of a complete division, from floor to roof, without any sort of interior communication, of the barrack building, thus making it into rooms destined for a small number of persons, in no case exceeding ten. The common plank beds should be replaced by individual beds, even if these have to be made of wood. The fact that this has been arranged for on some estates shows that there is nothing impracticable about it.

As for cubic air-space, allotment of quarters, and the ventilation of these—hygienic factors commonly neglected—it is indispensable that particulars be furnished to the health officer to enable him speedily and effectually to impose his authority regarding these matters.

The local epidemics of influenza and pneumonia which frequently manifest themselves in the dry season on certain estates are mainly due to these deficiencies in housing—common dormitories and imperfect ventilation.

In the days when Angolan serviçaes predominated, serving on long-term contracts, employers used to favour intermarriages among them. The present-day policy, however, is exactly the reverse: existing anterior unions between serviçaes of different sexes are often refused recognition, and as a rule marriages within the limits of the estate are not permitted. Such a line of policy is a blunder, for family life is always more hygienic, chance connections only serving to keep prostitution alive and spread venereal disease throughout the estates. The masters state that the rights conceded to those who want to live as husband and wife give rise to sanguinary quarrels, inspired by jealousies and acts of adultery; but any inconvenience of this kind might be partially avoided by the formation of small nuclei of independent dwellings for married couples, after the fashion of the locations of the Transvaal mines or the *tembas* of Mozambique.

Much more might be said on this subject. What seems to us quite easily brought into immediate execution is as follows: Division of the labourers' barracks into independent compartments for a reduced

number of persons; separate beds instead of running shelves of planks; insistence upon internal cleanliness and frequent disinfection should any contagious disease arise. The frequency of the infecto-contagious diseases (influenza, pneumonia, pulmonary tuberculosis, etc.), which in the last three years have caused throughout the island an annual mean mortality of 10·1 per mille, would at once diminish under these simple precautionary arrangements.

Feeding of the Labourers.

As a rule the ration is sufficient and of fair quality on most estates. The elements of it are—rice, millet, beans, salt meat, dried fish and more rarely fresh fish, with palm-oil as a fatty matter. Employers generally allow their men to gather all the wild-fruit on the estate, and of this there is abundance in the form of coco-nuts, bread-fruit, bananas, pineapples, etc.

Diseases due to the lack of certain antitoxic principles, such as beri-beri, scurvy, and pellagra, are almost unknown on the island; any cases of beri-beri observed of late have invariably been imported ones. Nevertheless the Mission would advise the replacement of milled rice, so commonly used in the dietary of the serviçal, by ordinary red rice —*i.e.*, not completely stripped of its pellicle. Its alimentary value is superior to that of the former kind, and in the pericarp of the grain are principles, playing a most important part in the human economy, which are eliminated by the process of polishing.

On this subject of feeding, it would further be advisable to have a periodical revision of the scale of rations and a certain supervision of their issue, as also of the working of the kitchens.

Disposal of Human Dejecta.

This is one of the weakest points in the local hygiene. The high mortality from ankylostomiasis proves it, for in the last triennium the rate rose to 7·4 per mille as the annual mean. Intestinal helminthiases are among the commonest causes of admission into hospital, and they contribute largely to the weakening and the invaliding of a considerable proportion of the workers of both sexes.

Latrines for natives are almost unknown anywhere in the island. Fæces are dropped indiscriminately in the plantations or the adjacent

forest, largely tainting the soil and the surface water. Thus the sources of infection by means of intestinal worms are, so to speak, infinite in number.

The prophylaxis of intestinal helminthiases at present forms a problem demanding urgent solution. It rests on various arrangements.

Let us first look at the question of the removal of dejecta. It does not seem to us impracticable in some of the properties to build latrines forming part of the *terreiros* (courtyard and surrounding buildings of the estate), on the customary lines, discharging into fixed cesspools, or in other cases with movable buckets, or, wherever possible, draining into the sea; and these latrines should have a number of seats proportionate to that of the labourers and employés.

There is meanwhile an economical system, easily constructed, with the further advantage that it can be widely spread throughout the plantations so as to avoid the fouling of the ground on any large scale by the workers in the field, as at present happens. We refer to the system of trench latrines, which, in default of anything better, serves quite well enough. There is nothing easier than the construction of a latrine of this kind. You dig an excavation in the ground of a suitable width and depth, as far as possible from the springs or rivulets whose water may be used for drinking or cooking, and cover it over with a frame made of trunks of trees supporting a layer of earth and stones of a certain thickness, leaving only an opening on which to place a removable box with a hole in it for the use of the individual. A hut of any material and fashion, sufficiently ventilated, with a water-tight roof overhead, will protect the visitor and at the same time keep the rain-water out of the trench. Thus, in these fosses fæces and urine alone will be deposited. From time to time a certain quantity of loose earth should be mixed in, adding ashes or lime as an absorbent and disinfectant. When the ditch becomes almost full, it will be closed by a layer of rammed earth, and the latrine transferred to another site.

Once an estate owner can get his natives accustomed to the use of this improvement, he will have succeeded in bettering their general health and at the same time put their droppings to better use as manure for the enrichment of his lands.

One more point in the prophylaxis of ankylostomiasis which lies in the province of the doctor—that of a greatly increased employment of thymol, so as to make it play the part in the locality of quinine or atoxyl.

Fig. 65.—Southern Section, Babilonia Swamp, Terreiro Velho, now Dry.

The third part of the crusade against the worms producing anemia is that which deals with the question of *corromissa*. This cutaneous, erosive affection of the toes, commencing almost always in the interdigital spaces, is nothing more or less than the *ground-itch* of English writers and the *mazamorra* of the West Indies. Its relations with ankylostomiasis, whether the lesions are produced directly by the entrance of the larvæ through the skin, or whether they have a different etiology and only favour the penetration of the worm, is now a settled point. The prophylaxis of ankylostomiasis locally implies protection against *corromissa*.

In the rainy season, when the soil is humid and muddy, the number of cases of incapacity for work due to *corromissa* rises to over 10 per cent. of the field labourers. If we could overcome it, we should attain a double advantage: hygienic and economic.

The prophylaxis of *corromissa* is above all things mechanical; it can be escaped by going about shod. The question arises, Why cannot a system of footgear, which shall be cheap, sufficiently impermeable, and adaptable to the conditions of local work and to the configuration of the ground, be devised for use in Principe? To the man who can work out this idea in practice, both the planter and the labourer will owe a debt of gratitude.

The adoption of boots or shoes for field work would have yet another far-reaching advantage: it would enable the wearers to escape many of the enormous ulcers of the lower extremities which drive the doctor to despair and represent one of the heavy burdens of the employer in the matter of medical attendance upon his labour establishments. Into the slow evolution, at times phagedænic, of these lesions there undoubtedly enters, in a high degree, the organically vitiated constitution of these people, upon whom alcoholism, paludism, and syphilis have placed their indelible mark. But among their occasional causes there constantly figure traumatic lesions of various kinds: it may be the usual cut from the hatchet, or excoriation from the sharp edges of the basalt, or, again, some scratch from collision with a superficial root or the trunk of a fallen tree. These accidental wounds, with infections subsequent thereto, would lose much of their importance were the use of shoes or boots made the rule.

The programme of practical prophylaxis of ankylostomiasis should thus rest upon the following points: Scattering around the estates of latrines on the dry-earth trench system; the extensive use of thymol

as a prophylactic and curatively; the prevention of *corromissa* by the adoption, after due experiment, of the type of footgear best suited to local agricultural requirements.

Alcoholism.

In the island this scourge of the negro race makes itself felt with greatest intensity among the native population. As for the serviçaes, they can only get drink in the form of wine on the roças from the canteens of their employers; and as the latter, for reasons of discipline, do not encourage drunkenness on their properties, the quantity of intoxicating liquor the former can obtain is strictly limited.

On the Roça Infante D. Henrique alone, under the protection of a licence which is about to come to an end, is the distillation of *aguardente* from sugar-cane permitted; on the other properties wine imported from Portugal is the sole drink consumed.

This state of things, as regards internal life on the roças, though not to be considered bad, is nevertheless capable of being improved upon. It would be sufficient were the law to prescribe a maximum quantity which the planter might sell to each one of his serviçaes—say, for example, half a litre of wine per diem—and that the number of days on which liquor might be sold be restricted to two or three. By the customs entries and the books of the estate it would be comparatively easy to discover whether the law was being complied with or not.

It is forbidden already to supply liquor from the shops of the estate to serviçaes not belonging to that estate. As far as wine is concerned, according to current talk, this rule is not universally obeyed, and it would be very desirable that the contravention of it should in no case go unpunished.

The supervision over the sale of wine to the natives should also extend to the public establishments in the town. As matters at present stand, the serviçaes of distant roças can only occasionally come in to get drunk in town; and this would not happen at all did not recent legislation recognize the right for them to absent themselves for longer or shorter periods without the leave of their masters.

Both on these grounds, and also because alcoholism runs riot among the native population, the Mission is of opinion that here, as in any other colony, wine should only be sold to natives in limited quantities, to be drunk on the premises, and never in vessels of larger content to

be removed for consumption elsewhere. By fortifying this provision of law with another imposing heavy fines upon any trader found selling wine or other alcoholic liquor to a native in a manifest state of intoxication, we should erect, in a very simple form, a formidable barrier against the worst vice of the negro race.

The law closing places of business on Sundays, and on weekdays at 7 p.m., when enforced with vigour, would fall into this scheme of social protection as an auxiliary of value.

Where the damage produced by alcoholism is at present most manifest and most intense, is among the natives of the island. The moral, financial, and physical decadence now pervading the *filhos da terra* may to a great extent be traced to the ravages of alcohol. Their endless entertainments, the mystic ceremonies in which they so delight, shared in by all classes, including public functionaries of a certain category drawn from the coloured population, are little else than a pretext for continued and repeated libations, abundantly supplied by the wine club, of beer and of the *cachaça* (rum) manufactured on the Roça Infante D. Henrique and sold in the establishments of the town.

In former days, when the natives possessed more property than now, the traditional feast of San Lourenço, usually degenerating into a kind of bacchanal, used to give rise to a considerable number of fatal accidents among the native population, through the disturbances arising out of it. We cannot resist transcribing the following description given us by the apothecary, Senhor Rodrigues, as a fair idea of what that celebrated feast, now fallen from its pristine splendour, used to be:

"Rehearsals for the festivities began a month beforehand, and before each rehearsal, almost daily, there were dances. On St. Anne's Day the performers, and almost all the people, went with flags flying and drums beating, after making a tour through the town, to pay their visit to the Church of Santa Anna, on the roça of that name. On that day the *festa*, both in the town and on the roça, lasted the whole night. On August 5 and 6 carnival was held; processions of masqueraders perambulated the town during the afternoon and part of the night, to the sound of drums, bagpipes, and rattles of coco-nut and bamboo. Then followed the three days' feast of San Lourenço, in which there were open-air representations of the history of Charlemagne.

"On the 11th the banqueting began, the feast-givers keeping open house, with table always spread and *batuques* (negro dances) going on.

Fig. 66.—Drainage Works on Margins of Rio Papagaio: Roça Bellavista.

Next came a novena to Our Lady of the Rosary, ending up with a chanted Mass and a grand feed and *batuque* in the house of the feast-givers to Our Lady. After that there were *festas* nearly every day in the different churches, which at that time were numerous, in fulfilment of vows made by their many faithful, these too being accompanied by banquets and *batuques*, each host vying with the others in providing an entertainment more brilliant and . . . more copiously washed down. . . ."

Thus the religious spirit instilled into these people by the good old Catholic missionaries has degenerated into an excuse for stupendous orgies, in which the abuse of alcohol makes common cause with the most unbridled licentiousness, preparing for the native population a future of ruin, which is even now at hand. To justify the need for repressive measures against alcoholism in the island we do not think more can be said than the above.

Medical Attendance.

The arrangements for the care of the sick on the agricultural estates may be regarded, taking into account the means of the majority of their owners, as fairly good. The larger estates possess hospitals of their own, the smaller ones dispensaries, as a rule sufficiently equipped, with rooms attached for the segregation of one or more patients. The latter, in more serious cases, are transferred to the Government hospital.

According to law, all have a doctor provided, who pays periodical visits to each, more or less frequent according to the strength of the establishments maintained by the estate, and is liable to be called in besides to attend to urgent cases. Some possess a qualified European hospital assistant, but in most cases it is the European headquarters assistant in charge of the *terreiro* who takes charge of the treatment of the sick and is responsible for the carrying-out of the doctor's prescriptions; in others the estate manager himself, assisted by a native for the dressings and nursing work, who looks after the sick.

Evidently this scattering of medical service throughout each and all the estates, in the light of the fact that, with the exception of the three or four large estates, the island agriculture is carried on in small-scale plantations with establishments under 150 serviçaes, is not to the general advantage. The cost of a service thus organized is high,

the assiduity of the medical man, upon whom such a number of petty calls are imposed and who has to travel long distances to attend to his patients, cannot be great, and the tending of the sick by employés who have many other matters to take up their time, cannot possibly be perfect.

We suggest the adoption of a system of central infirmaries, one for each group of adjoining roças, kept up by proportional contributions made by the owners or companies associated for this purpose. This condensation of hospital services would permit of a greater regularity in clinical work and a more perfect system of nursing. The employers would gain both by spending less and by obtaining a marked shortening of the period of detention of the labourer in hospital, which means less absence from duty on the part of the hands engaged; and the latter, for their part, would secure better regard for the needs of their case.

What is here outlined is no innovation. In the Rand some mines, with more than 500 labourers, cannot have a hospital of their own, so they make use of those of larger concerns, paying a fixed rate per day per patient, or associate themselves with other mines in order to meet the expenses of a common infirmary.

Working Arrangements.

The system followed in the island in this respect is perfectly unobjectionable. The daily task is, on an average, one of ten hours, with a holiday on Sundays. It would seem advisable to drop the practice of cleaning up the *terreiros* (yards) and *sanzalas* (native lines) on Sunday mornings. This duty might well be performed on the Saturday afternoons, so that the labourers should have the Sunday quite free for their own relaxations.

And the practice, adopted in some places, of locking up the *sanzalas* from outside after 9 p.m. is neither sensible nor hygienic. It would be better to do as is done in the Rand mines; there the *terreiros* (known as " compounds ") are rectangular in shape, with a single entrance, which is closed at night. In this way the ventilation of the dormitories can be better secured on the hottest nights, and free access afforded to the privies, which, as in the Transvaal, should communicate with the *terreiro* by means of a special passage.

Paludism.

The quinine prophylaxis of paludism among the Cabo Verde serviçaes, seeing that the mechanical defence of the *sanzalas* only produces illusory results, is of great importance in local hygiene. Malarial manifestations, acute or chronic, are of great frequency among this class of the population, and their tolerance for the hæmatozoa is small. As we have said, the latest systematic examinations of the population of the island show that the mean of infected persons among the Caboverdeans is 8·6 per cent. There was one roça in which, out of 72 individuals, nearly all of them natives of Cabo Verde, there were 33 carriers of the hæmatozoa in the most varied forms !

Prophylaxis by means of quinine offers yet another advantage of considerable range. In many cases it appears that the aggravation of the tropical sores of the lower extremities which so often attack these natives is due to a certain degree of latent malarial infection, and it has sometimes been possible to shorten the evolution of these or to lower the percentage of those suffering from them by the daily and systematic administration of 0·5 gramme of any of the salts of quinine most in use.

Inspection at Ports of Emigration.

Some simple but rigorous system of identification of the contracted hands is badly wanted. Coming from Cabo Verde, with contracts in order and a competent medical certificate of inspection, entirely impossible people sometimes turn up—men suffering from chronic maladies. Admitting—and there is no reason for supposing the contrary—that the inspection at the port of departure has been carried out with the necessary rigour, such occurrences are only explicable by fraudulent substitutions arranged by the men among themselves and carried out at the time of starting.

Vaccination.

Smallpox is unknown on the island, but there is always the risk of its introduction by means of the immigrants continually coming to it. It is very urgent to protect the colony against the invasion of a malady so terrible in its effects and to which the negro race displays so marked a susceptibility. The simplest and most advantageous plan would

be to insist upon vaccination at the port of embarkation for all contracted labourers. The operation could be effected concurrently with the medical examination, and on arrival the health officer would verify the fact that it had been complied with. All those who did not show signs of recent vaccine pustules would be at once revaccinated here.

For the rest, vaccination should be generalized throughout the island, and the Board of Health proposes to arrange for this to be done.

Cerebro-Spinal Meningitis.

As it is intended shortly to introduce immigrants from the province of Mozambique into the island, the greatest precautions should be taken against the importation of this malady, which may give rise to deadly epidemics. One of the precautions which ought at once to be adopted is the construction of an isolation shed for infecto-contagious diseases as an annexe to the hospital, and this, it is hoped, will be set up within a short time.

Sanitation of the Town of Santo Antonio.

Very shortly the capital, the only town in the island, will be provided with a series of improvements of a sanitary nature, of which it has been sadly in need, a general plan of major works being under consideration and likely to be started without delay. The matter has to be arranged between the municipality and the Board of Ports and Communications of the province, and it is a sufficient guarantee of the practical success of the negotiations that Senhor Ezequiel de Campos is at the head of the Public Works Services in San Thomé and Principe.

NOTE.—The references made in this chapter to the native régime in the Rand mines have been taken from the report of the Curator of Portuguese natives in the Transvaal, signed by Dr. Serrão de Azevêdo, for the year 1912-13, the first work published since the creation of that post in 1897.

PART V

CHAPTER I

STUDY OF THE TRYPANOSOMIASES OF THE ISLAND OF PRINCIPE

By J. FIRMINO SANT'ANNA.

(*Drawings by the Same.*)

As our arrival in the island took place in October, 1913, when, owing to the advance made in the work of prophylaxis, flagellate infections had become rare, it was only with difficulty that we obtained suitable materials for this study, a point previously dealt with by the Correia Mendes Mission (1907-08), but which it is as well to recapitulate, discussing it somewhat in the light of the progress made of late years in one of the most complex sections of tropical pathology.

As the sanitary provisions of law compelling the immediate elimination of all animals found to be carriers of trypansomes as soon as their infection had been diagnosed were in force in the island, this explains the scantiness of the material available to us, and the deficiency of clinical observations of natural infections, to which unfavourable circumstances has to be added the marked deficiency of animals for experimental purposes.

Trypanosomes of the Congo Type.

Giving preference to the nomenclature proposed by Broden for a monomorphic trypanosome without free flagellum, of which the *dimorphon*, the *pecorum*, and perhaps also the *nanum*, may be regarded as so many other modalities,* and adopting the classification of Yorke

* The earliest description of the *dimorphon* was published by Dutton and Todd in 1903 (Liverpool School of Tropical Medicine, Memoir xi., 1903). Laveran and Mesnil, studying a trypanosome furnished by those authors, adopted a similar denomination, but in a different sense, as the characters observed by them did not correspond to the description of Dutton and Todd, who, it appears, had in their

and Blacklock,* we will describe four races of *congolense* isolated by us in November, 1913, to March, 1914, three of oxen and one of a mule. With the exception of the last-named, which came from Portugal, the other animals were from Southern Angola, the oxen having been in the island from three to twenty months, and the mule five months.

Trypanosoma congolense—Race I.

Origin.—Obtained by inoculation into rats from the blood of ox *Couto* of the Roça Terreiro Velho; diagnosis made by means of thick preparations, method Ross-Ruge, commonly employed by the Mission in the detection of cases of infection; the infected animal had only been three months in the island.

Movements.—In fresh preparations of blood from infected animals, between the slide and cover-glass it is seen that the movements of the parasite are but little active, and that it only makes short excursions within the field of the microscope. It shows a marked tendency to attach itself to the red globules, sometimes hiding itself on the monticuli of the corpuscles, at other times sticking to them by its flagellated extremity. Its local movements are those of rolling and unrolling. When it moves about, it does so with the flagellated extremity first, and its locomotion seems chiefly determined by the vibration of the undulant membrane.

Morphology.—In preparations of dried blood, spread out, and coloured by means of the Leishman stain, it is seen that one is dealing with a species without free flagellum, although in rare parasites this may for a short extent exceed the terminal protoplasmic lamina of its body.

The posterior extremity is sometimes rounded, at others in the form of a short cone, and may also be truncated. As a rule, proto-

hands not a single species, but a mixed infection (*Compt. Rend. de la Académ. des Scien.*, March, 1904, p. 732); still, the characterization of the *congolense* had been made a month before the memoir of Laveran by Broden (*Bull. de la Soc. des Études Colon*, February, 1904) on animals from the Belgian Congo. In 1910 Bruce and his colleagues (Proceedings of the Royal Society, 1910, B 82, p. 468) proposed the name *pecorum* to include the two species, and it seems to us, meanwhile, according to the opinion of various authors, that the priority of nomenclature should rest with Broden, since the identity of the two species is admitted.

* Yorke and Blacklock, "Differentiation of the more important Mammalian Trypanosomes," *Annals of Tropical Medicine and Parasitology*, April, 1914, vol. viii., No. 1, pp. 1-12.

plasmic granulations are not noted. In some parasites the protoplasm colours with greater intensity and takes the basic colours better than in others.

The micro-nucleus is more or less rounded, assuming a neat coloration. It is placed very near to the posterior extremity of the trypanosome, almost always close to its concave border, not jutting out beyond the edge of the protoplasm; sometimes in the middle part of its thickness; and less frequently close to its convex border. Around the micro-nucleus there is often to be found a space clearer than the rest of the parasite, but still not presenting the character of a true vacuole.

The nucleus occupies the central part of the parasite, and sometimes it is even distinctly anterior; it is of oval form, lengthening out considerably in the more lanky forms of the parasite. In dry preparations the chromatin shows some tendency to take on a radiate disposition; in other cases it densifies itself more on the peripheral zone of the nucleus.

The flagellum begins to make itself visible on the edge of the clear zone enclosing the micro-nucleus.

The undulant membrane is as a rule narrow and little sinuous. At times it does not describe more than one complete undulation, including one concave and one convex curve. Oftener we may regard it as describing an undulation and a half—that is to say, a semi-undulation in one direction and two in the opposite. Two complete undulations is an infrequent case, and three are only exceptionally seen in the very elongated forms. The border of the membrane projects altogether, perhaps in half the number of cases, towards the same side of the parasite, and in the rest towards both sides.

The presence of a circular vacuole situated a little behind the nucleus, followed, it may be, by one or two more or less dimensions, is noted with comparative frequency.

The length of this trypanosome oscillates between 10 and 21 microns, with a mean of 14·7 microns; its breadth varies from 0·5 to 2·7 microns, the mean being 2 microns. Those of smaller dimensions at times present the classic form of tadpoles.

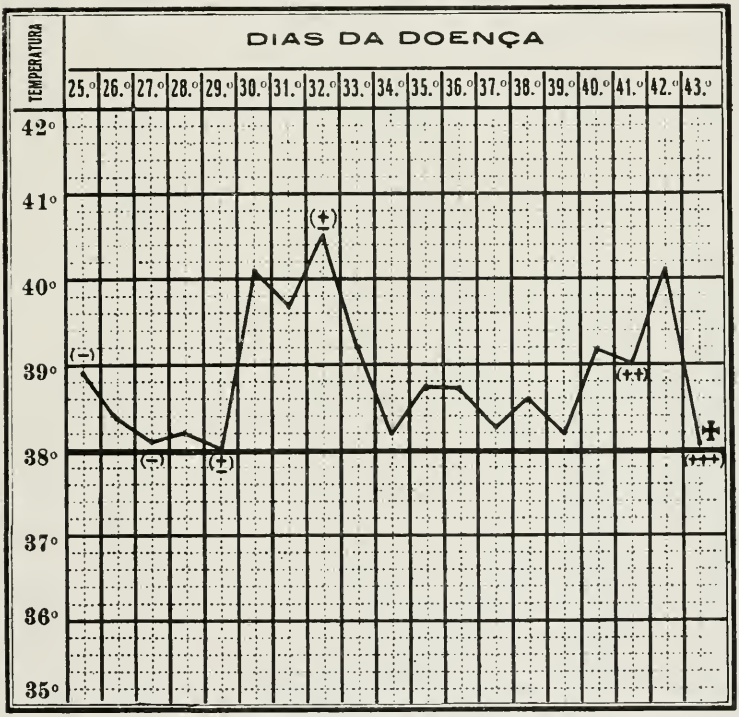
Its biometric curve has its vertex in the ordinate corresponding to the length of 15 microns, with a tendency to a minor acumination in the column of 13 microns. From 10 to 13 microns it rises rapidly, and starting from 15 up to 21 microns, its fall is also in rapid descent.

Division takes place, beginning at its posterior extremity; first the micro-nucleus, the flagellum to follow, then the nucleus, and lastly the protoplasm.

CHART VI.

TRYPANOSOMA CONGOLENSE: RACE I. (OX COUTO).

Temperature Chart ; Dog No. 1.



(—) Result of examination negative.
(±) Few trypanosomes.
(+) Some trypanosomes.
(++) A fair number of trypanosomes.
(+++) Many trypanosomes.

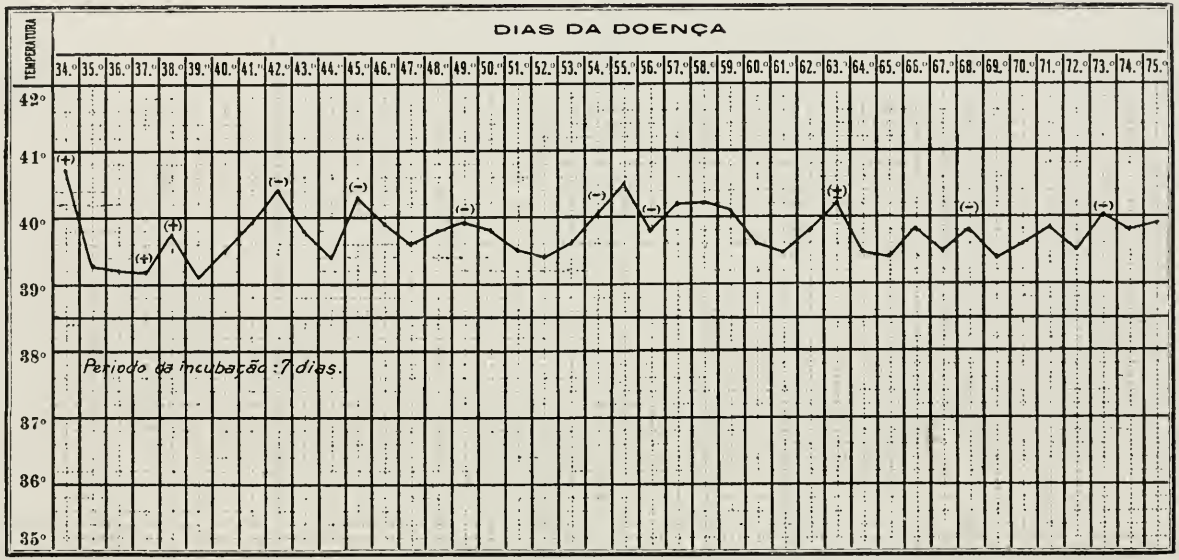
Temperatura = Temperature. *Dias da Doença* = Duration of Sickness in Days.

According to their dimensions and their general form, we may take into consideration four categories of parasites, without there being, however, any clear distinction between them: (1) Very short forms (10 to 11 microns), including the trypanosomes of tadpole shape;

CHART VII.

TRYPANOSOMA CONGOLENSE: RACE I. (OX COUTO).

Temperature Chart ; Monkey No. 3.



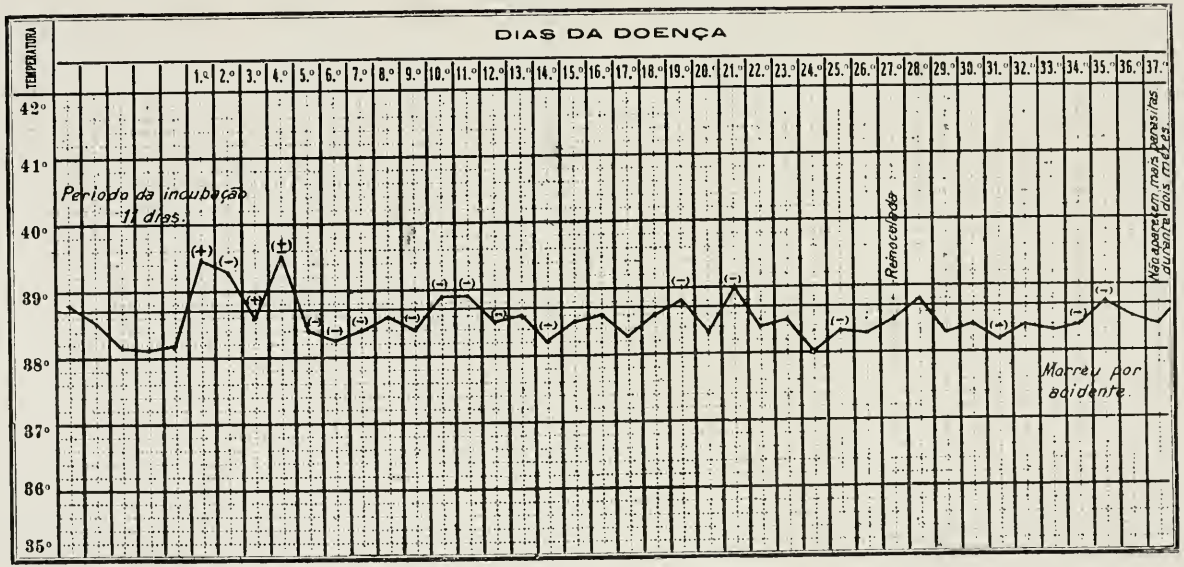
(—) Result of examination negative. (±) Few trypanosomes. (+) Some trypanosomes.
(++) A fair number of trypanosomes. (+++) Many trypanosomes.

Temperatura = Temperature. *Dias da Doença* = Duration of Sickness in Days.
Periodo da incubação : 7 dias = Period of incubation: 7 days.

CHART VIII.

TRYPANOSOMA CONGOLENSE: RACE I. (OX COUTO).

Temperature Chart ; Goat No. 1.



(—) Result of examination negative. (±) Few trypanosomes. (+) Some trypanosomes.
(++) A fair number of trypanosomes. (+++) Many trypanosomes.

Temperatura = Temperature. *Dias da Doença* = Duration of Sickness in Days.
Periodo da incubação : 11 dias = Period of incubation: 11 days. *Reinoculada* = Reinoculated.
Não aparecem mais parasitas durante dois mezes = No more parasites appeared within two months.
Morreu por acidente = Death due to accident.

(2) medium forms (12 to 17 microns), narrow, undulant membrane not very distinct, protoplasm not very dense; (3) medium forms, broader than the foregoing (2 to 2·7 microns in width), undulant membrane ampler, protoplasm taking a blue coloration with greater intensity—in these there are to be seen protoplasmic juxtanuclear vacuoles in their posterior part; (4) very elongated forms (18 to 21 microns), undulant membrane of narrow width but very sinuous, having possibly the anterior extremity of the flagellum free for a short extension.

Pathogenic Properties.—In the ox, the carrier of the natural infection, the clinical symptoms at the date of its discovery were *nil*.

Rats, guinea-pigs, rabbits, monkeys, dogs, and goats show themselves constantly susceptible to this parasite. In the rat, the guinea-pig, and the dog, the infection runs a rapid course.

In five rats the mean period of incubation was 9 days, and the average life of the animal after its infection 80 days. The parasites showed themselves almost constantly present in the peripheral blood during the course of the disease. In the final period keratitis was observed, producing blindness of one or both eyes. In autopsy the spleen showed a considerable increase in bulk.

The mean period of incubation in the case of the guinea-pigs was 11 days, and the animals survived for 23 days, the parasites remaining present in the blood, sometimes in great numbers. Enlargement of the spleen was likewise observed on autopsy.

In the single rabbit inoculated the period of incubation was 10 days; the parasites were frequent at first, but the animal recovered afterwards spontaneously.

The course of infection in a dog was acute, producing thermic oscillations between 37° and 40° C. (*vide* Chart above). The animal died at the end of 43 days, with considerable hypertrophy of the spleen. Incubation, 9 days.

In a monkey (*Cercopithecus mona*, the only species on the island) the incubation was not long delayed (7 days), but the infection took on a chronic form, with a small number of parasites at the beginning of its evolution, spontaneous cure taking place later.

In a goat the infection also took on a chronic form, without sensible elevation of temperature and without any other apparent symptoms. The animal died at the end of four months of an intestinal obstruction, without splenic enlargement, and apparently cured.

The inoculation of a cat gave a negative result. A curious change

took place in the colour of the coat of this animal, which from its original black turned white, apparently the effect of the captivity in which it was kept at first. It died some months later, the consequence of a quarrel with another of its kind.

The more important data of our experimental inoculations will be found summarized in the subjoined table (Table XI.).

As a notable peculiarity let us mention the existence of forms of inclusion in the red globules of the blood of the rat. In one of these figures there was observed, inside the erythrocytes, a reticulated mass of chromatin, representing the nucleus of a trypanosoma, and a blue-coloured cake formed by its protoplasm, one and the other of these being contained within a clear space. The general aspect of these intraglobular forms, anyhow extremely rare, is the same as that of certain phases of the phagocitosis of the trypanosome by the leucocyte.

Hönhel* had already mentioned the phenomena of the penetration of the *congolense* into the red corpuscles, while Laveran raised a doubt on the point.

Trypanosoma congolense—Race II.

Origin.—Obtained from a mule of the Roça Terreiro Velho, brought from Portugal, which had been five months on the island; diagnosis arrived at by the usual process.

Movements.—There is little to be added to what is already recorded in the case of the preceding parasite (Race I.). It shows a tendency perhaps greater towards agglutinating itself to the red corpuscles and to grip these by its flagellated extremity, a phenomenon which also occurs with the leucocytes.

Morphology.—Identical with that of the preceding trypanosome. It seems to have a greater constancy as regards the presence of the post-nuclear vacuole, accompanied or not by others secondary to it. The frequency of intermediate forms, of wide type and dense protoplasm, sometimes with granulations, seems also greater. The nucleus frequently approximates more to the anterior than to the posterior extremity. The greatest breadth of the parasite is to be found in the part posterior to the nucleus, narrowing much in that anterior to it.

The mean of its dimensions, as may be seen by comparison of Tables XIII. and XIV., does not differ sensibly from that of the preceding one. In any case some forms with 8 and 9 microns of length may be observed,

* Arch. für Schiffs und Tropen Hyg., 1908, Bd. 3 (cited by Laveran).

TABLE XI.—PATHOGENIC ACTION OF THE TRYPANOSOMA CONGOLENSE, RACE I.: PARASITES OF THE OX COUTO.

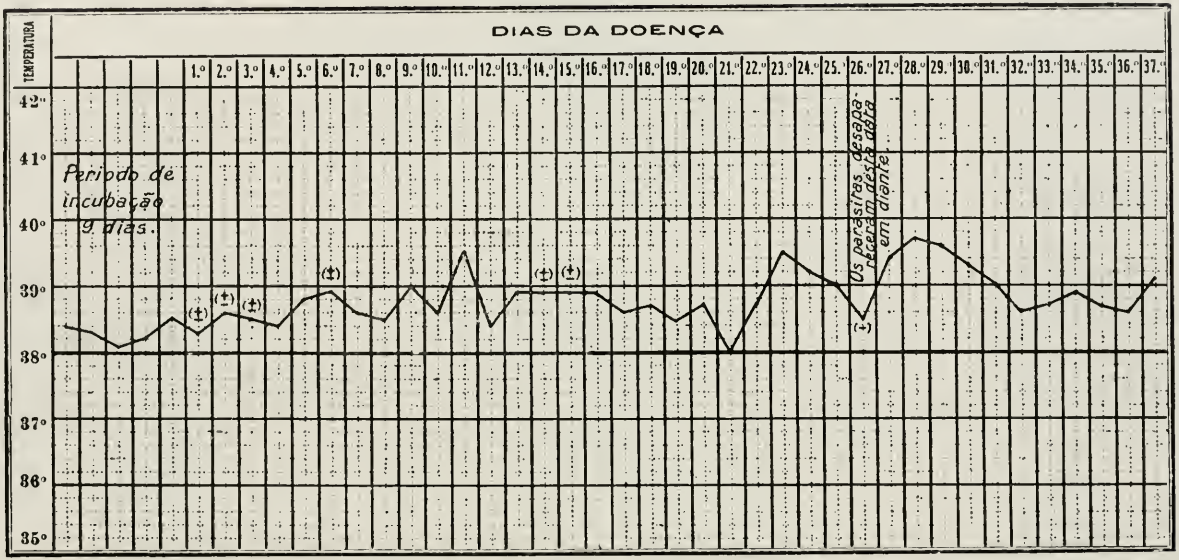
Animal inoculated.	*Origin of the Virus.*	*Period of*— Incubation.	*Period of*— Sickness up to Death.	*Parasites in Blood.*	*Symptoms observed.*	*Remarks.*
		Days.	Days.			
Rat V. ..	Ox Couto	8	67	Almost constant	Keratitis	Spleen found enlarged on autopsy
Rat VI. ..	Ditto	8	48	Ditto	Ditto	Ditto
Rat VII. ..	Subinoculated from Rat V.	9	125	Present up to 90th day of infection	Nil	—
Rat VIII. ..	Ditto	11	147	Ditto	Nil	Infested with gamasides; attacked by itch
Rat XVI. ..	Subinoculated from Guinea-pig VII.	11	22	Constant	Keratitis	Enlarged spleen
Guinea-pig I.	Subinoculated from Rat VII.	9	29	Ditto	—	Ditto
Guinea-pig II.	Ditto	16	18	Ditto	—	Ditto
Guinea-pig VII.	Ditto, Rat V.	9	7	Ditto	—	Accidental death
Monkey III. ..	Ditto, ditto	7	—	Up to 60th day		
,,	First reinoculation through Guinea-pig VII.	12	—	Up to 5th day	Maximum temperature, 40·4° C.	Alive and healthy four months after first inoculation
,,	Second reinoculation through Rat XVI.	—	—	No parasites seen		
Rabbit III. ..	Rat V.	10	—	Up to 110th day	—	Ditto, ditto, six months after
Goat I. ..	Subinoculated from Rat VII.	17	—	Up to 3rd day	Maximum temperature, 39·5° C.	Died four months after, by accident
Cat I. ..	Subinoculated from Rat V.	—	—	Always negative	Hair turned white	Died five months after (traumatism)
Dog I. ..	Ditto, ditto ..	9	43	Constant	Lost flesh	Spleen much enlarged

Animal inoculated.	*Origin of the Virus.*	*Period of*— Incubation.	*Period of*— Sickness up to Death.	*Parasites in Blood.*	*Symptoms observed.*	*Remarks.*
		Days.	Days.			
Rat III. ..	Mule *Figueira*	—	—	—	—	Inoculation negative
Rat IV. ..	Ditto	—	—	—	—	Ditto
,,	Subinoculated from Rabbit II.	—	—	—	—	Ditto
Rat XII. ..	Monkey IV.	—	—	—	—	Ditto
Rat XIII. ..	Ditto	—	—	—	—	Ditto
Rat XXIII. ..	Monkey V.	8	45	Constant	—	—
Guinea-pig V.	Rabbit II.	—	—	—	—	Died by accident
Guinea-pig VI.	Ditto	—	—	—	—	Inoculation negative
,,	Reinoculated through Monkey IV.	—	—	—	—	Ditto
Guinea-pig XI.	Monkey V.	8	14	Constantly rare	—	Young animal; weight 260 grammes
Guinea-pig XII.	Ditto	—	—	Negative to 20th day	—	Inoculation negative
,,	Reinoculated through Monkey V.	—	—	—	—	Ditto
Rabbit I. ..	Mule *Figueira*	—	—	Constantly negative	—	Died 48th day after inoculation
Rabbit II. ..	Ditto	73	—	Rare to 60th day	—	Cured
Rabbit IV. ..	Monkey IV.	15	—	Present with intermissions to 6th month	—	Living, and without apparent illness, 7 mos. after inoc.
Rabbit VII. ..	Monkey V.	24	—	Present during first two months	—	Alive three months after
Monkey IV. ..	Rabbit II.	15	—	Present with intermissions	Maximum temperature, 40·5° C.	Alive 6 mos. aft 1; no visible sickness
Monkey V. ..	Rabbit IV.	13	—	Constant; at times abundant	Maximum temperature, 40·8° C.	Alive 4 mos. after; no visible sickness
Dog III. ..	Monkey IV.	13	—	Present up to 20th day	Maximum temperature, 39·8° C.	Alive and apparently cured 4½ mos. after
,,	Reinoculated through Monkey V.	—	—	Negative	—	
Sheep II. ..	Monkey V.	15	—	Constantly rare	—	Chronic course of infection

CHART IX.

TRYPANOSOMA CONGOLENSE: RACE II. (MULE FIGUEIRA).

Temperature Curves ; Dog III.



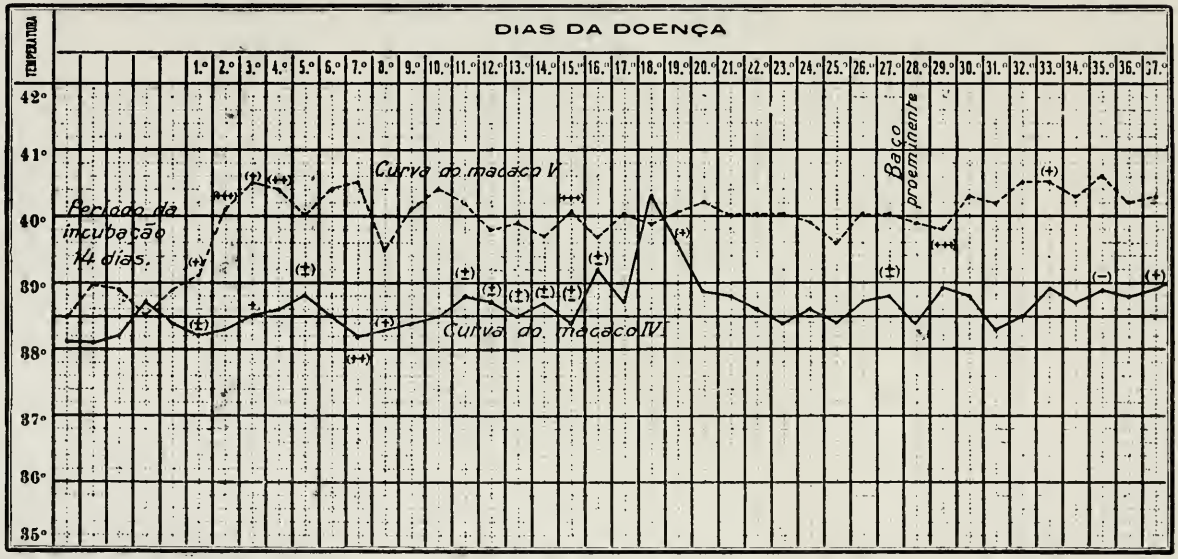
(—) Result of examination negative. (±) Few trypanosomes. (+) Some trypanosomes.
(++) A fair number of trypanosomes. (+++) Many trypanosomes.

Temperatura = Temperature. *Dias da Doença* = Duration of Sickness in Days.
Periodo de incubação : 9 dias = Period of incubation: 9 days.
Os parasitas desappareceram desta data em diante = The parasites disappeared from this date out.

CHART X.

Trypanosoma congolense: Race II. (Mule Figueira).

Temperature Curves ; Monkeys IV. and V.



(—) Result of examination negative. (±) Few trypanosomes. (+) Some trypanosomes.
(++) A fair number of trypanosomes. (+++) Many trypanosomes.

Temperatura = Temperature. *Dias da Doença* = Duration of Sickness in Days.
Periodo da incubação ; 14 *dias* = Period of incubation: 14 days. *Curva do Macaco V.* = Curve of Monkey No. V.
Curva do Macaco IV. = Curve of Monkey No. IV. *Baço proeminente* = Spleen prominent.

the minimum length of 500 parasites of Race I., as measured, being 10 microns.

The curves of the percentages of forms of equal length are meanwhile perfectly superimposable, both having their maximum in the column corresponding to 15 microns, as may be verified from the respective charts.

Pathogenic Properties.—The infected mule did not, when diagnosis was made, present any appreciable morbid symptoms whatever. The first passages were made through rats and rabbits.

The attempts at direct inoculation of the rats, as well as the subinoculations, were steadily fruitless throughout six months of experiment; but in the meantime we finally succeeded in getting positive results in the case of two wild rats, with a mean incubation of 8 days, by using the virus of a powerfully infected monkey.

Guinea-pigs likewise showed themselves refractory for a long time. By using the highly-charged virus of the same monkey, we obtained positive results on a guinea-pig two weeks old, which died after 14 days of infection, its period of incubation having been 8 days.

Infection in the rabbit is always very attenuated, and the animals recover spontaneously; very few parasites, and very difficult to find; the period of incubation varies from 15 to apparently 73 days.

In a dog that was injected the parasites made their appearance at the end of 13 days; they were still visible during the first 20 days to follow, and only slight febrile movements were noted; thereafter they vanished, and an attempt to reinoculation gave negative results.

In sheep and goats only slight infections were produced, without any apparent symptoms.

In monkeys the incubation was 14 days as a mean. In one case a slight infection, with parasites always rare and thermic movements almost imperceptible; and in another, inoculated after various passages through rabbits and through the monkey above mentioned, there were thermic elevations of from 1 to 2 degrees centigrade. The parasites have always been numerous in the peripheral blood, and the spleen has sensibly enlarged in bulk.

The parasites of this last monkey infected a wild rat and a young guinea-pig. Both the monkeys are alive, the first with six and the second with four months' evolution of the infection.

From the blood of monkey No. V., strongly infected by this parasite, and also showing a marked leukocytic reaction, there are frequently to

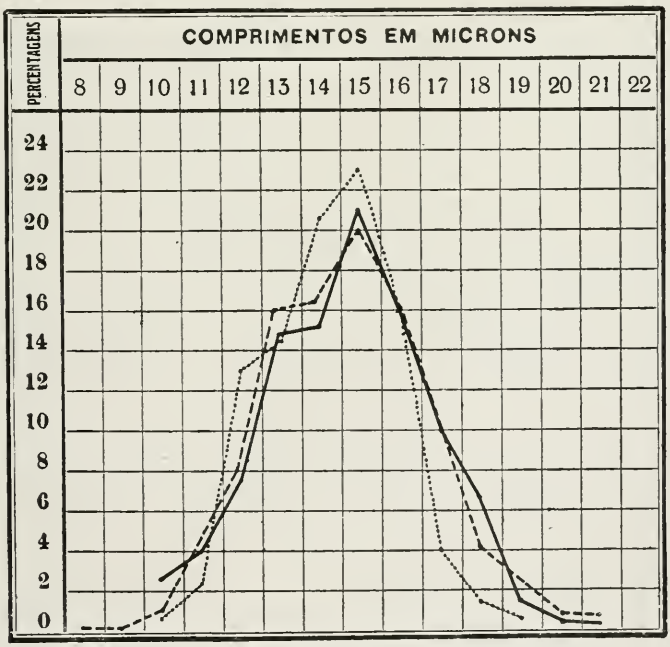
be seen forms of encystment in the great mononuclears, perfectly similar in all respects to the figures of slow phagocytosis, which may be seen in the lymphoid organs of the rat infected by the *rhodesiense*. A single macrophage of the blood of the monkey may contain four of these cysts.

Trypanosoma congolense—Race III.

Origin.—Ox Lima from Roça Porto Real; animal had been 20 months on Principe. The first inoculations were made on rats and rabbits.

CHART XI.

TRYPANOSOMA CONGOLENSE: CURVES SHOWING THE LENGTHS, IN PERCENTAGES, OF THE THREE RACES.



——— Curve relating to the trypanosomes of the ox Couto in the rat (Race I.)
..... Curve of the trypanosomes of the mule Figueira in the monkey (Race II.).
} 500 parasites of each were measured.

Curve of the trypanosomes of the ox Lima in the rat (Race III.)
} 250 parasites were measured.

Percentagens = Percentages.
Comprimentos em microns = Lengths in Microns.

Movements and Morphology.—Similar to those of the other two races. Some forms are found with the posterior extremity very dilated, reminding one of the profile of the trypanosoma discovered in 1909 by Montgomery and Kinghorn in the dogs of Rhodesia (*T. Montgomeryi*).* Its dimensions (mean) nevertheless differ but slightly from those of the preceding races, and it keeps itself much on a level with those as far as length and breadth are concerned, the latter measurements being constantly on a level with the nucleus. The maximum length, 250 parasites being taken, was a little less than that of Race I., that being 21 microns, while that which we are now describing was 19 microns. By a comparison of the respective charts we may see that the percentage of forms of more than 16 microns falls somewhat in Race III. in relation to that of the two other varieties.

Pathogenic Properties.—Rats show themselves susceptible, the infection in their case taking on an appreciable development, and so do rabbits, but these only show very few parasites. One of the rats inoculated died 50 days after infection, its incubation period being 8 days. We tried the inoculation of a dog, but without result.

SUMMARY OF THE MEAN OF THE THREE FIRST RACES OF TRYPANOSOMA CONGOLENSE.

Table XIII.—Trypanosomes of the Ox Couto: Race I.

Animal.	*No. of Parasites measured in Length.*	*Length in Microns.*			*Breadth in Microns across the Nucleus.*		
		Max.	Min.	Mean.	Max.	Min.	Mean.
Rat XVI. ..	500	21	10	14·7	2·7	1·4	2·0

Table XIV.—Trypanosomes of the Mule Figueira: Race II.

Animal.	*No. of Parasites measured in Length.*	*Length in Microns.*			*Breadth in Microns across the Nucleus.*		
		Max.	Min.	Mean.	Max.	Min.	Mean.
Monkey V. ..	500	21	8	14·6	2·8	1·3	1·9

* *Annals of Tropical Medicine and Parasitology*, vol. iii., No. 2, 1909.

TABLE XV.—TRYPANOSOMES OF THE OX LIMA: RACE III.

Animal.	*No. of Parasites measured in Length.*	*Length in Microns.*			*Breadth in Microns across the Nucleus.*		
		Max.	Min.	Mean.	Max.	Min.	Mean.
Rat XII. ..	250	19	10	14·35	3·0	1·2	1·95

Trypanosoma congolense—Race IV.

Origin.—Ox Bandeira from Roça Porto Real, nine months on the island. Isolated by inoculations into rats and rabbits.

Movements and Morphology.—Similar to the foregoing. The parasites were always so scanty in the blood of the experimental animals that their study has proved rather incomplete.

Pathogenic Properties.—Rats and rabbits showed themselves susceptible to direct inoculation; infection slight, parasites very few and inconstant.

Diagnosis.—If we admit within the class of short and monomorphic trypanosomes, most frequent in mammals, the separation of species claimed to exist by the school of Laveran and Mesnil, founded chiefly on proof of cross immunity, we shall find it difficult, in the absence of similar data, to place within their classification the parasites we have here studied.

From the standpoint of the results of the measurements we are inclined to hold that the three first varieties present a mean length inferior to that of the *dimorphon*, according to Laveran, and superior to that of the *congolense* (Laveran), the *pecorum* (Bruce), and the *nanum* (Bruce).

The nearest type to the parasites we have studied, both by its mean dimensions and by the trace of its biometric curve, is realized by the *T. nanum*, according to the description given by Kinghorn and Yorke in the report of the English Mission of Aruangua.* The curve of Race III., for example, reproduces with sufficient fidelity the curve of these authors for the *nanum*.

* *Annals of Tropical Medicine and Parasitology*, vol. ii., No. 2, June, 1913, pp. 248-249.

As to biological reactions, the parasites studied show a mean virulence sensibly inferior to that which the treatises ascribe to any of the typical species of the *congolense-dimorphon* group; Race I. alone approaches them in its pathogenic qualities. Race II., which at first reminded one of *T. nanum* by the absence of infective properties in the cause of rats and guinea-pigs, even if other small laboratory animals, such as the rabbit, the dog, and the monkey, have always shown themselves susceptible, ended up by developing itself, after several passages, in the blood of a wild rat and a young guinea-pig. Both this, and also Races III. and IV., never produced more than very slight infection, and only exceptionally victimized the carrier.

The inconstancy of the pathogenic action of the parasites of the *congolense-dimorphon* group is a fact which has been latterly brought to the front by various experimenters, among whom we may cite Blacklock and Yorke* and Delanoe†, so much so that the legitimacy of the species *nanum*, which seemed well established by its non-inoculability upon the small experimental mammals, is now placed in doubt.

Micrometric data have not yielded, in the hands of the different experimenters, that constancy which is desirable; and, on the other hand, the criterion of cross-immunity is not of easy application in current practice. So we will adopt the classification of Yorke and Blacklock, and follow it in regarding the former species *dimorphon* and *pecorum* as varieties of the *congolense*.

Our diagnosis of *congolense* in the case of the four parasites studied, whose strict relationship, for the three first, seems to us sufficiently demonstrated by the resemblance of the respective biometric curves, and for the fourth by the morphologic type alone, thus implies for this term that latitude assigned to it by the authors quoted above.

A Trypanosome of the Cazalboui Type—Trypanosoma uniforme.

In May of the current year (1914) a case of infection by this parasite was discovered in an ox on the Roça Infante D. Henrique, a property in the south of the island, in a zone reputed at all times free from glossinas. It appears from the note furnished by the management of

* "The Probable Identity of *Trypanosoma congolense* and *T. nanum*," *Annals of Tropical Medicine and Parasitology*, 1913, vol. vii., No. 4, pp. 603-607.

† "Des Variat. du Pouv. Infect. et de la Virul. du *T. dimorphon*," *Bull. de la Soc. de Pathol. Exot.*, January, vol. vii., No. 1, pp. 58-63

the estate that the animal had been eight years in the island, had never gone beyond that zone, and had originally come from Cabo Verde. These circumstances, coupled with the fact that the Correia Mendes Mission in 1907 had never come across any case of infection of a similar nature in the island, suggested the hypothesis of a form of importation of long chronicity, and as the animals exported from Cabo Verde are often brought from the Guinea Coast, this might also be the true origin of the infection.

The recent appearance of similar cases of infection in sheep from the south of Angola, newly arrived in the island, started a second hypothesis—namely, that there might have been some mistake in the information furnished to the Mission as to the origin of the animal, and it might have come from the same region as the sheep. It would be very interesting to study this and other epizootia in their sources of origin, but we believe that up to the present nothing has been done in this direction.

Origin of the Parasite.—An ox of the Roça Infante D. Henrique, said to have been imported from Cabo Verde. The diagnosis was made by the usual process, and the trypanoscme studied directly in the blood of its host and in goats inoculated with the blood of the former.

Movements.—Remarkably lively. The parasite does not as a rule go beyond the edge of the field of vision of the microscope, but within this it makes longer or shorter excursions with great rapidity. Its local movements are so rapid that at times it becomes invisible, and its presence is only known by the vibration it communicates to the globules and to the fluid medium. Seen thus in fresh film, between slide and cover-glass, it appears much less refractive than the trypanosomes of the group previously described.

Morphology.—Although fairly short, it distinguishes itself easily from the trypanosomes of the *congolense* group by possessing in most cases a small flagellum perfectly free. This flagellar excrescence is only exceptionally wanting, and then only in the shortest forms.

The protoplasm does not show granulations. In some specimens longitudinal zones of a colouring differing in intensity stand out to distinguish them, and it seems as if the parasite is trying a kind of *plissage*, or that it has got doubled back upon itself in the drying of the preparation, a fact perhaps due to the extreme tenuity of the protoplasm above mentioned.

The posterior extremity is sometimes rounded or obtuse, at others

conical, more or less thready. The micro-nucleus is always close to it, and may even be terminal. In the slenderer forms, in which the parasite seems doubled upon itself, its coloration is not very distinct. Sometimes it is involved in a clearer zone of protoplasm, but does not appear to have a true vacuole.

The nucelus is placed in the middle part of the parasite, or a little anterior to it. The undulant membrane is narrow and but slightly sinuous, with a tendency to project entirely to the same side. In the forms already cited, in which there may be observed a kind of longitudinal duplication, the projection of the membrane may occur altogether over its median part.

The length of the parasite, including the flagellum, varies between 11 and 22·5 microns, the mean being 15·94. The width across the nucleus ranges from 1·3 to 2·7 microns, giving 1·6 as the mean. We have already pointed out the apparent reason for the marked narrowing of some forms.

The biometric curve has its *acme* in the ordinate corresponding to forms of 15 microns as in the *congolense*, presenting a second acumination, less elevated, in the column of 18 microns. The percentage of the forms of more than 16 microns is much superior to that of the *congolense*.

Pathogenic Properties.—The ox, the carrier of the natural infection, showed as its principal symptom an accentuated atrophy of the muscles of the posterior members, betraying a certain difficulty in the gait of the animal. In virtue of this atrophy there was a visible diminution in bulk of the rump, it being noted that the tissues here were flaccid, that there was an exaggerated protrusion of the bony prominences, and that there was loss of hair in places. A mucous discharge was also observed from the nostrils; but this was not very abundant, and was inconstant. During two months under observation the condition of this animal remained appreciably unchanged. The appearance of parasites in the blood took place during this period intermittently; sometimes they were numerous, at others scanty, and at times they were not to be detected by means of direct examination. The temperature remained between 39° and 40·2° C., without pronounced oscillations.

The only animals which contracted the infection experimentally were goats and sheep.

The attempts at inoculating three rats, two guinea-pigs, two rabbits, two dogs, one cat, and a civet-cat (*lagaia*), were totally fruitless.

In two goats and a sheep the period of incubation oscillated between 8 and 10 days. One of the goats died after 15 days' illness. The animal had an old and extensive dermatose following itch; its temperature fluctuated between 39° and 39·3° C. The sheep, which was also suffering from a long-standing itch, died after 19 days of infection, displaying in the last days of its illness an extensive œdema in the anterior part of the neck, with symptoms of asphyxia. On this occasion subconjunctival ecchymoses were observed.

We would observe that the activity and extent of the movements of this parasite afford us certain differences according to the animal the carrier of it, and, further, some daily variations. In a general way its mobility seemed to us greater in the sheep and goats than in the blood of the ox. In the former, movements from place to place predominated; in the latter, local vibrations, but these were of extraordinary vivacity. On certain days, studying the fresh preparations of the blood of the former, the excursions of the parasites did not pass beyond the field of the microscope, while in the others they went rapidly outside its ambit, losing themselves to sight of the observer.

Diagnosis.—The non-susceptibility of experimental animals other than ruminants, the presence of a free part of the flagellum, and the rapidity of its movements, betray the close relationship of this parasite with the *T. cazalboui* or *vivax*.

Its dimensions are, however, sensibly inferior to those assigned by the authors either to the *cazalboui* (21 microns average length according to Laveran) or to the *vivax* (16 to 31 microns according to Ziemann), and we should likewise note that the average amplitude of its movements of translation seems less than that of these species.

Of the species described, that which most closely approaches it is the *T. uniforme*, discovered by Bruce in Uganda in 1911, measuring between 12 and 19 microns in length by 1·5 to 2·5 microns in breadth. As we have not been able to consult the original work of that authority,* we have meanwhile satisfied ourselves, by reference to it made by other writers,† that the biometric curve set forth in the present report only differs from that of the *uniforme* by a lower percentage of the forms between 17 and 19 microns.

* Report of Sleeping Sickness Commission, Royal Society, No. 11, 1911, pp. 160-164.

† Kinghorn and Yorke, *Annals of Tropical Medicine and Parasitology*, June 10, 1913, vol. ii., No. 2, pp. 266-267.

TABLE XVI.—PATHOGENIC ACTION OF THE TRYPANOSOMA UNIFORME.

Animal inoculated.	*Origin of the Virus.*	*Period of*— Incubation.	*Period of*— Sickness up to Death.	*Parasites in Blood.*	*Symptoms observed.*	*Remarks.*
		Days.	Days.			
Rat XII. ..	Goat III.	—	—	—	—	Inoculation negative
Rat XIII. ..	Ditto	—	—	—	—	Ditto
Rat XXIV. ..	Ox Pantaleão	—	—	—	—	Ditto
Guinea-pig X.	Ditto	—	—	—	—	Ditto
Guinea-pig XII.	Goat III.	—	—	—	—	Ditto
Rabbit III. ..	Ox Pantaleão	—	—	—	—	Ditto
Rabbit VII. ..	Goat III.	—	—	—	—	Ditto
Dog VI. ..	Ox Pantaleão	—	—	—	—	Ditto
Dog VII. ..	Goat III.	—	—	—	—	Ditto
Monkey VII.	Ox Pantaleão	—	—	—	—	Ditto
Goat III. ..	Ditto	9	15	Constantly present, sometimes in large numbers	—	Attacked with itch
Sheep I. ..	Ditto	—	—	—	—	Negative to 22nd day
,,	Reinoculated through Goat III.	8	19	Intermittently present	Œdema of the anterior part of the neck; symptoms of asphyxia; subconjunctival ecchymoses	Attacked with itch
Goat II. ..	Sheep I.	10	106	Always rare; movements very active	—	Formerly inoculated with *T. gambiense*
Cat III. ..	Goat III.	—	—	—	—	Inoculation negative
Civet-Cat III.	Ditto	—	—	—	—	Died fifteen days after without any parasites shown

TABLE XVII.—RÉSUMÉ OF MEASUREMENTS OF THE TRYPANOSOMA UNIFORME.

Animal.	*No. of Parasites measured each Day.*	*Length in Microns.*			*Breadth in Microns.*		
		Max.	Min.	Mean.	Max.	Min.	Mean.
Ox Pantaleão natural infection ..	100	22·5	12·5	17·17	—	—	—
Ditto ..	100	22·5	12·5	15·95	—	—	—
Ditto ..	100	21·0	11·0	13·50	—	—	—
Ditto ..	100	21·0	12·5	13·79	—	—	—
Ditto ..	100	21·0	12·5	13·30	—	—	—
	500	21·6	12·2	15·94	2·7	1·3	1·6

The Trypanosoma gambiense in Principe.

From December, 1913, to March, 1914, we studied in the island three specimens of *T. gambiense*, two of which corresponded to local infections, a third having been imported from the Portuguese Congo. The two island parasites turned out in the course of the observations to belong to two distinct varieties, one of them removing itself sensibly from the classic form of *gambiense* by a certain number of details of its morphology, and in particular by the high percentage of long forms in certain experimental animals; and the other identifying itself perfectly with the type species. The Congo parasite presented nothing special to our notice.

We have not characterized the first of these parasites as a distinct species, bearing in mind as we do in the first place the variability of which the *gambiense* is susceptible in the matter of dimensions, and in the second place the poorness of our material for inoculations, which has not allowed of our attaining means of confidence. In our work, therefore, we must take it as an elongated variety, local, of the *gambiense*.

Elongated Variety of the Trypanosoma gambiense.

Origin.—A parasite isolated from the patient Sotero Fernandes, a native of Cabo Verde, employed as a serviçal on the Roça Sundy, with two years and three months residence on the island. We practised

inoculations into rats with the sediment of the cerebro-spinal fluid containing a large number of parasites.

Movements.—When fresh, forms of unusual length are distinguishable, with a long free flagellum, and others short, thicker, and without visible flagellar appendix.

The first-named have lively movements, hurrying rapidly from one side to the other, but seldom going beyond the microscopic field of vision. The parasite travels almost invariably with the flagellum in front, seldomer in the opposite direction, and its movements are essentially undulatory. From time to time it suspends its march, often without any obstacle being visible, to resume it subsequently in a different and unforeseen direction. Its movements are capable of being accelerated in an extraordinary fashion, and then it seems rather to vibrate than to undulate.

The journeyings of the short forms, when they occur, are performed within a limited ambit. These remain for long periods on the same spot, oscillating round it in movements of curling and uncurling of their spirals, these being few in number. All this is done with great deliberation.

Morphology. — Coloured preparations show that we are dealing with a dimorphic trypanosome, discriminated out into elongated forms, more or less narrow, with a long flagellum, and others of shorter and thicker form without free flagellum, or only with a rudiment of this part of their locomotive apparatus.

From the point of view of dimensions, the elongated forms may be defined as belonging to the third category of Bruce's classification—that is to say, forms measuring between 25 and 39 microns in length, their mean breadth across the nucleus being 1·5 microns.

Making use of the parasites of the rat and of the guinea-pig as the type, let us point out in the first place the absence of protoplasmic granulations in these lengthened forms, and the great frequency of figures of division. In these forms the details of the posterior extremity are particularly characteristic, and we may assume the existence of the following types:

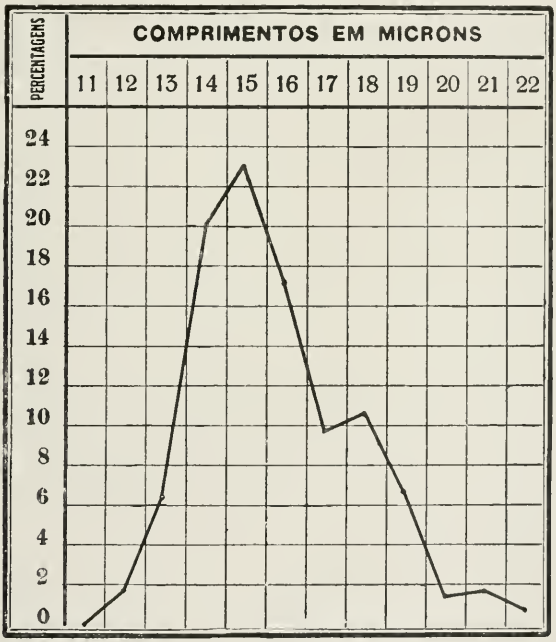
1. Posterior extremity elongated or tapering to a point, reaching or even exceeding the length of 3 microns, starting from the micronucleus.

2. Spatula-shaped or duck-billed, the lateral edges being parallel or slightly divergent from front to back. Its length, taken from the

micronucleus, does not as a rule exceed 2 microns. The axis of this part of the trypanosome may be approximately rectilinear, in prolongation of the direction of the axis of the posterior part of its body. or it may curve, either in the same direction as that of its general curvature or in the opposite direction. In the latter case we may say

CHART XII.

TRYPANOSOMA UNIFORME: SHOWING THE LENGTHS, IN PERCENTAGE, OF THE TRYPANOSOMES OF THE OX PANTALEÃO.



Five hundred trypanosomes were measured on five different days, 100 per day.

Percentagens = Percentages. *Comprimentos em Microns* = Lengths in Microns.

that there has been retroflexion of the posterior extremity, or that the latter is retroflected.

3. Shape of a thick cone slightly over 2 microns.

4. The same—a thick cone of similar dimensions but truncated.

5. The same—a very short cone, more or less acuminate, with the micronucleus near the vertex, this last being perhaps juxta-posterior. This is the commonest shape of the ordinary *gambiense*.

The forms with the posterior extremity very elongated and tapering to a point are more numerous in the rat than in the guinea-pig; the spatulated forms are those most frequently to be found in one and the other animal. The exaggerated broadening of the free end of the spatula precedes its bifurcation, which forms part of the mechanism of division of the parasite.

The micronucleus is rounded, it colours intensely, and is often situated in the posterior environment of a vacuole well marked. The greatest distance to the extremity of the parasite never exceeds 4 microns.

The macronucelus. in these very elongated forms, is placed approximately at the junction of the posterior third with the anterior two-thirds of its longitudinal axis; its shape is oval, more or less narrow; at times it is so elongated that we may describe it as filleted.

The undulant membrane is narrow and very sinuous, describing generally four or five complete undulations, and as a rule the three first of these project towards the same side of the parasite, between the micronucleus and its tapered part; the remainder, in transition towards the free flagellum, project first to one, then to the other, side.

The free flagellum measures between 5·3 and 7·3 microns, the mean length being 6·2 microns.

The short forms measure from 16 to 22 microns in length, and we may consider them as belonging to Bruce's first group. They are thicker than the foregoing, their average breadth across the nucleus being over 2 microns. In more than half the cases there is no free flagellum. Where one is observed it is always short, very rarely exceeding 2·5 microns in length.

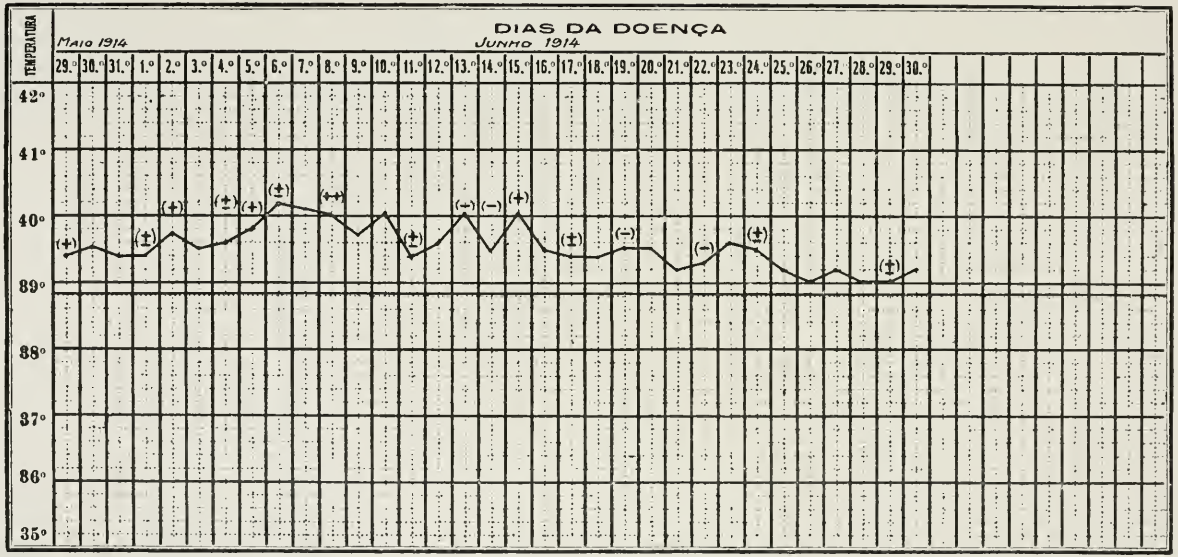
These forms invariably terminate in a short wide cone, or rather in an ogive, the micronucleus being very close to its vertex, and may even occupy it, the respective distance being on an average 1·1 microns.

The macronucleus is rounded, or quadrilateral with the angles rounded off. In the 16 to 18 micron-forms it is placed approximately half-way along the length of the trypanosome, and in those of greater length nearer the posterior than the anterior extremity. As the distance from the nucleus to the posterior extremity varies within narrow limits, both in these and in the long forms, it happens that the longer the trypanosome the remoter the nucleus from its median part. The minimum distance measured between the middle of the nucleus and the posterior extremity, in 50 of these short forms, was 6·5 microns; of forms with the nucleus posterior, properly speaking we saw none.

CHART XIII

TEMPERATURE CHART OF OX PANTALEÃO FOR THIRTY-THREE DAYS.

Trypanosoma uniforme.



(—) Result of examination negative. (±) Few trypanosomes. (+) Some trypanosomes.
(++) A fair number of trypanosones. (+++) Many trypanosomes.

Temperatura = Temperature. *Dias da Doença* = Days of Sickness.

The undulant membrane is visibly wider, and with sinuosities not so deep as in the longer forms. The maximum total breadth of the parasite, including the undulant membrane, may reach 4 microns. The latter as a rule projects entirely to one side, this corresponding almost invariably to the convex margin of the parasite.

In these forms as a rule phenomena of division were not observed.

In Bruce's group of so-called intermediary forms, between 22 and 24 microns in length, there do not actually appear parasites with distinctive characters. The narrowest, with a long flagellum, belong to the first type which we have described; the others, broader, with rudimentary flagellum, are included in the second.

Admitting the existence of this transitional group, place would be found in it for certain others of an elongated shape but under 22 microns in length, besides the parasites included within the numerical limits indicated, and for yet a small number of the broad type but over 24 microns.

The essential character of this trypanosome is its dimorphism; the intermediate forms are not a type of their own, and only establish a passage between their two fundamental morphological groups.

Table XVIII.—Comparative Table of the Three Classes of Trypanosomes established by Bruce.

Parasite.	*Short Thick Forms:* 13-21.	*Intermediate Forms:* 22-24.	*Long Thin Forms:* 25-39.
	Per Cent.	Per Cent.	Per Cent.
Trypanosoma gambiense, long variety (Principe), in rats and guinea-pigs (500 measured in each of these animals)	6·5	11·0	82·5
T. gambiense, according to Bruce (1,000 parasites in different animals)	51·2	23·1	25·7
T. rhodesiense, according to Stephens and Fantham (1,000 parasites in rats)	36·1	19·8	44·1
T. brucei, according to Bruce (1,000 parasites in the rat)	32·	25·5	41·7

The high frequency of the long forms in the rat and the guinea-pig, far exceeding what the authors state to be normal for the common *gambiense* in these animals, is another important point to be borne in mind when studying this Principe variety. If we consult the

comparative table on p. 196 relating to the percentages of forms of diverse lengths, grouped according to the classification of Bruce,* we shall see that this trypanosome has given us 82·5 per cent. of long forms (25 to 30 microns) in the same animals, on measurement of 1,000 parasites, against 25·7 per cent. in the *gambiense*, according to Bruce, 44·1 per cent. in the *rhodesiense*, according to Stephens and Fantham, and 41·7 per cent. in the *brucei*, again according to the first of these authors. The corresponding comparative chart will make so extraordinary a discordance quite plain.

The mean of the lengths in the parasite studied by us in Principe was, as the fresh statement which follows will show, 28·5 microns, whereas that mean for the *gambiense*, according to Bruce, is 22·1 microns.

Table XIX.—Comparative Table of Maximum, Minimum, and Mean Lengths in Three Human Parasites, and also in Trypanosoma brucei.

Parasite.	*Lengths in Microns.*		
	Max.	Min.	Mean
Trypanosoma gambiense, long variety (Principe) (1,000 parasites in the rat and the guinea-pig) ..	39	16	28·51
T. gambiense, according to Bruce (1,000 parasites in the rat)	33	13	22·10
T. rhodesiense, according to Stephens and Fantham (1,000 parasites in the rat)	39	12	23·60
T. brucei, according to Bruce (1,000 parasites in the rat)	38	13	23·20

In the comparison of the biometric curves, or rather of the charts showing the percentages of the forms of equal length relative to the long variety of Principe and to the *gambiense*, a similar contrast is revealed. The curves we obtained by measuring 500 parasites in the rat and in the guinea-pig on ten different days, at the rate of 50 a day, have their maximum level between 29 and 33 microns in the rat, and between 28 and 33 microns in the guinea-pig. The curve of Bruce's *gambiense* reaches its greatest elevation between 19 and 21 microns, and that of Stephens and Fantham similarly, in the form of a broken-down arch, marks its maximum percentages in the columns between 23 and 29 microns.

* Proceedings of the Royal Society, December 8, 1911, B. 572, pp. 327-332.

TABLE XX.—RÉSUMÉ OF MEASUREMENTS OF THE VARIOUS PARTS OF THE TRYPANOSOMA GAMBIENSE, ELONGATED VARIETY. ANIMAL INOCULATED, GUINEA-PIG NUMBER OF PARASITES MEASURED, FIFTY OF EACH GROUP.

Parts of the Parasite measured.	*Short Forms:* 16-21.	*Intermediate:* 22-24.	*Long Forms:* 25-29.	*Mean.*
Total mean length	18·6	22·8	29·4	23·60
Mean distance, posterior extremity to micro-nucleus	1·1	1·5	2·4	1·66
Mean distance, macro- to micro-nucleus ..	5·7	5·9	6·3	5·96
Length of nucleus	2·4	2·7	3·3	2·80
Mean length of flagellum	1·2	2·5	6·2	3·30
Percentages of flagellated forms	50 per cent.	85 per cent.	100 per cent.	—
Mean breadth across the nucleus	2·13	1·67	1·66	1·82

TABLE XXI.—RÉSUMÉ OF MEASUREMENTS OF TRYPANOSOMA GAMBIENSE, ELONGATED RACE OF PRINCIPE.

Animal.	*Day of Sickness.*	*Number of Parasites measured.*	*Length in Microns.*		
			Max.	Min.	Mean.
Guinea-pig III.	45th	50	35	23	29·10
,, ,, ...	46th	50	36	20	29·08
,, ,, ...	47th	50	36	19	24·64
,, ,, ...	48th	50	39	18	28·88
,, ,, ...	49th	50	36	17	27·36
,, ,, ...	50th	50	35	16	26·34
,, ,, ...	51st	50	36	22	29·16
,, ,, ...	52nd	50	36	17	26·80
,, ,, ...	53rd	50	36	17	26·56
,, ,, ...	54th	50	37	16	26·28
		500	36·2	18·5	27·42

Breadth { Maxima, 3·0. Minima, 1·1. Mean, 1·75.

In the general outline of these curves other interesting peculiarities: the curve of the Bruce *gambiense* rises rapidly from 14 to 19 microns, to descend slowly thereafter from 21 to 36 microns; the curves of the local variety rise first slowly up to the column of 28 microns, their

descent from 33 to 39 microns being rapid. Superposition would only be possible after the rotation of one of them through 180 degrees around one of the median ordinates of the chart—that is to say, the relation between the biometric curve of the common species and that of the long variety of the island, at least in the rat and guinea-pig, is not one of similarity but of geometric symmetry.

We have had occasion to observe that the numerical characteristics of this parasite become somewhat modified in the different experimental animals. In the dog, the cat, the monkey, the civet-cat (*lagaia*), the forms having dimensions over 30 microns fall sensibly in their frequency, those over 35 microns being rare.

Table XXII.—Résumé of Measurements of the Trypanosoma gambiense, Elongated Variety, of Principe, in the Monkey.

Animal.	*Day of Sickness.*	*No. of Parasites measured.*	*Length in Microns.*		
			Max.	Min.	Mean.
Monkey III.	16th	50	33	16	24·10
,, ,, ...	17th	50	35	17	25·00
,, ,, ...	23rd	50	30	16	23·70
,, ,, ...	24th	50	31	18	24·90
,, ,, ...	25th	50	33	14	27·70
,, ,, ...	31st	50	33	17	24·30
,, ,, ...	32nd	50	34	18	25·86
,, ,, ...	33rd	50	33	17	24·96
,, ,, ...	37th	50	29	16	21·58
,, ,, ...	38th	50	30	15	19·42
		500	32·1	16·4	24·15

Where these differences made themselves most perceptible was in monkeys. When we inoculated two of these animals, both of the same species, one with the common *gambiense*, got from a patient in the island, the other with the elongated local variety, we obtained with the latter a curve different from those furnished us by the guinea-pig and rat.

The curve of the elongated variety, in the monkey, shows two maxima, one between 20 to 22 microns, the other between 26 to 29 microns. Things go on as if the animal had two different parasites,

one giving a curve similar to that of the *gambiense* of Bruce, the other showing a greater percentage of long forms, but still without reaching the means of our long variety in the rat or guinea-pig.

The common *gambiense* of the island, in the monkey, gave us a curve of the same kind as that of Bruce, with a rapid ascension up to 19 microns, and a less sudden fall down to below 21 microns. There have, however, to be noted the high percentages of the measurements of 19 and 20 microns, which give it a more sharply pointed appearance, making it curiously similar to the curve of the *rhodesiense*, according to Kinghorn and Yorke.

TABLE XXIII.—RÉSUMÉ OF MEASUREMENTS OF THE TRYPANOSOMA GAMBIENSE, COMMON VARIETY, OF PRINCIPE, IN THE MONKEY.

Animal.	*Day of Sickness.*	*No. of Parasites measured.*	*Length in Microns.*		
			Max.	Min.	Mean.
Monkey I.	11th	50	25	16	19·80
,, ,, ...	12th	50	32	17	21·90
,, ,, ...	13th	50	35	17	23·50
,, ,, ...	17th	50	30	13	19·70
,, ,, ...	18th	50	24	13	19·60
,, ,, ...	19th	50	32	16	21·20
,, ,, ...	20th	50	31	15	20·90
,, ,, ...	21st	50	27	14	18·20
,, ,, ...	22nd	50	27	14	20·00
,, ,, ...	23rd	50	31	13	20·00
		500	29·4	14·8	20·53

TABLE XXIV.—COMPARATIVE TABLE OF THE GROUPS OF BRUCE IN THE TWO VARIETIES OF THE TRYPANOSOMA GAMBIENSE OF PRINCIPE, IN THE MONKEY.

	Short Thick Forms: 13-21.	*Intermediate Forms:* 22-24.	*Long Narrow Forms:* 25-39.
	Per Cent.	Per Cent.	Per Cent.
T. gambiense, long variety (500 parasites) ..	30·6	17·8	51·6
T. gambiense, common form (500 parasites) ..	73·8	14·2	12·0

Besides the variations from species to species, we have also observed, as was to be expected, variations between one individual and another within the same species, or from one day to another in the same animal.

The predominance of the very elongated forms both in the rat and in the guinea-pig seemed to us a fact very constant. The table of measurements of the parasites of the guinea-pigs during ten days shows meanwhile variations in their average length between 24·64 and 29·16 microns.

TABLE XXV.—COMPARATIVE TABLE OF MAXIMUM, MINIMUM, AND MEAN LENGTHS OF THE TWO VARIETIES OF HUMAN TRYPANOSOME IN PRINCIPE IN THE MONKEY, AND OF THE TRYPANOSOMA GAMBIENSE, ALSO IN THE MONKEY—THE LAST-MENTIONED ACCORDING TO BRUCE.

Parasite.	*Lengths in Microns.*		
	Max.	Min.	Mean.
T. gambiense, elongated variety, island of Principe..	35	14	24·15
T. gambiense, common variety, Principe	35	13	20·53
T. gambiense, according to Bruce*	31	15	22·40

In a rat inoculated by us with the long variety there were only to be seen forms of the short and thick type, loaded with metachromatic granulations distributed throughout the whole parasite. The animal died in a short time without showing any forms different from this.

That the fact may correspond to the existence of some condition or other adverse to the development of the parasite in the organic medium of its host is proved by the scarcity of trypanosomes in the peripheral circulation. Indeed in this case we only saw very rarely any specimens of the parasite at all.

The variations of the proportion of short forms and elongated in the monkey to which we have referred were, as may be seen from the chart respecting it, considerable, for the mean daily length oscillated between 19·42 and 27·70 microns during 10 days. In this animal the trypanosomes appeared intermittently, and it would happen that one

* Proceedings of the Royal Society, December 8, 1911, B. 572, pp. 327-332

day they were numerous, while the next day they were not to be found. In this animal there was an accentuated leucocytic reaction, which may perhaps explain both the intermittence of the infection of the peripheral blood and the predominance of the short forms—these apparently the more resistent—on certain days.

The thought suggests itself, and a hypothesis of this kind has already been examined in connection with other dimorphic trypanosomes of a possible mixed infection, in which, alongside the common *gambiense*, there may have been another parasite of an elongated type. The study we have made of experimental infections does not offer the least support favourable to this way of thinking; on the contrary, it convinces us that the conclusions of the authors who regard the short forms as adults and the flagellated forms as those of growth and multiplication,* contain in themselves, applied to the case, an important part of the truth. In a general sense the fall in the frequency of flagellated forms in these dimorphic parasites betokens the realization of conditions adverse to the production of their multiplicative cycle.

Pathogenic Properties.—We will sum up in a single table the results of our inoculations, which, owing to the very limited number of experimental animals at our disposal, have but little interest.

In the rat the incubation and duration of the disease have been, on an average, 17 and 38 days respectively; in the guinea-pig the mean of the former was 22 days, and two of these animals survived for more than three months.

In a single rabbit inoculated the incubation lasted 41 days, and it would seem that a spontaneous cure took place, or at least that the infection remains latent.

In two dogs the mean period of incubation was 10 days. One of them died, with atrophy and paralysis of the muscles of the hind-paws, at the end of 106 days of the sickness, the maximum temperature reached by it being 39·6° C.

We give the curve of temperature of a monkey inoculated with this trypanosome during 28 days; the oscillations occurred between 39·5° and 40·5° C., no correspondence being noted between these and the increase or decrease of parasites in the peripheral circulation.

The remaining data may be gathered from the following table:

* Robertson, Muriel, Proceedings of the Royal Society, October 11, 1912, vol. lxxxv., B. 582, pp. 527-539.

Animal inoculated.	*Origin of the Virus.*	*Period of—* Incubation.	*Period of—* Sickness up to Death.	*Parasites in Blood.*	*Symptoms observed.*	*Remarks.*
		Days.	Days.			
Rat IX. ..	Humana	18	40	Present in great quantity	Emaciation	Spleen slightly enlarged
Rat X. ..	Subinoculated through Rat IX.	—	—	—	—	Died 2 days after inoculation
Rat XI. ..	Ditto	14	53	Present throughout	Emaciation	Spleen little enlarged
Rat XIV. ..	Ditto	—	—	—	—	Died 18 days after inoculation
Rat XV. ..	Ditto	20	20	Very rare; at times absent	—	Spleen slightly enlarged
Guinea-pig III.	Ditto	17	—	Present throughout	—	—
Guinea-pig IV.	Ditto	20	101	—	—	Died by accident
Guinea-pig VI.	Guinea-pig IV.	30	7 mos.	Present throughout	—	—
Rabbit VI. ..	Ditto	41	—	Intermittent and very few	—	Alive and apparently well 4 months later
Dog II. ..	Rat IX.	11	106	Rare; present to 15th day	Emaciation, irascibility, paralysis of hind-paws towards the end. Max. temp., 39·6° C.	Lumbar puncture positive on 90th day of infection. Spleen normal in volume
Dog V. ..	Guinea-pig IV.	9	—	Rare; present to 30th day	Emaciation, irascibility	Killed by mistake 3 months after infection
Monkey III. ..	Ditto	9	—	Present with intermissions	Maximum temperature, 40·4° C.	Alive and apparently well 4½ months after inoculation
Goat II. ..	Ditto	11	—	Very few; present to 30th day	Maximum temperature, 39·8° C.	Apparently cured
Cat II. ..	Monkey III.	8	—	Rare	Conjunctivitis	Killed by chloroform 2 mos. after inoc.
Civet-Cat I. ..	Ditto	13	15	Numerous	—	Weight of animal, 1,080 grammes; of spleen, 50 grammes
Civet-Cat V...	Ditto	—	—	—	—	Died 11 days after inoculation

TABLE XXVII.—PATHOGENIC ACTION OF THE COMMÓN-VARIETY OF TRYPANOSOMA GAMBIENSE IN PRINCIPE.

Animal inoculated.	*Origin of the Virus.*	*Period of—*		*Parasites in Blood.*	*Symptoms observed.*	*Remarks.*
		Incubation.	Sickness up to Death.			
		Days.	Days.			
Rat XIX. ..	Humana	—	—	—	—	Died before parasites appeared
Rat XX. ..	Ditto	9	—	Very rare up to 44th day of infection	—	—
,,	Reinoculation through Monkey I.	—	—	—	—	Reinoculation negative
Monkey I. ..	Rat XX.	27	—	Negative up to 14th day	—	Alive and apparently free from infection three months later
,,	Reinoculated through Rat XX.			Almost constantly present		
Guinea-pig VIII.	Rat XX.	—	—	Negative up to 17th day	—	Inoculation and reinoculation negative
,,	Reinoculation through Monkey I.	—	—	—		
Civet-Cat IV.	Monkey I.	—	—	—	—	Died eleven days after inoculation without parasites appearing

TABLE XXVIII.—PATHOGENIC ACTION OF THE TRYPANOSOMA GAMBIENSE (COMMON) OF THE PORTUGUESE CONGO.

Animal inoculated.	*Origin of the Virus.*	*Period of*— Incubation.	*Period of*— Sickness up to Death.	*Parasites in Blood.*	*Symptoms observed.*	*Remarks.*
		Days.	Days.			
Rat XVII. ..	Humana	?	96	Always very rare	—	Animal infected by *T. lewisi.*
Rat XVIII. ..	Ditto	8	60	Ditto	—	Spleen normal
Guinea-pig IX.	Rat XVIII.	—	—	—	—	Inoculation negative
Monkey II. ..	Rat XVII.	38	—	Present in variable quantities	—	Showed *T. lewisi* in blood from 25th to 30th day from date of inoculation.

NOTE.—All the engravings in the present work were taken with the *camara clara* of Abbé, and with a constant amplification of 2,000 diameters.

For their colouring we have employed the Leishman process in the usual way. Notwithstanding the greatest efforts made by us to get the Giemsa stain in good condition, it was only at the end of our labours that the Mission succeeded in doing so; failing the Giemsa mixture, to have been applied to the colouring intended for the measurements of the parasites, we tried the the Leishman colouring after previously fixing it by means of absolute alcohol; but as this process turned out inferior to the current method of fixation and colouring at one and the same time, especially as regards the clearness of the flagellates, we gave it up.

To measure the length of the trypanosomes, we traced by means of the *camara clara*, as rigorously as possible, the median axis, which was afterwards measured by the recognized tangent process of Stephens and Fantham. The enlargement employed was always, as we have said above, one of 2,000 diameters.

Trypanosoma gambiense (Common Variety).

We obtained the classic species from a patient on the island, of four years' residence, a serviçal of the Roça of Terreiro Velho, and also from another native, the latter from San Salvador do Congo, who had arrived already infected on the island. Nothing of interest occurs to us to note upon the subject, so we confine ourselves to adding the tables showing the inoculations tried with one and the other parasite. We have already made reference to the curve representing the percentages of the forms of equal length relating to the common variety of *gambiense* of the island.

History of the Trypanosomes of Mammals in the Island of Principe.

Infection of the type *congolense-dimorphon* must have existed for a long time in the island. One of the factors which seem to have been most potent in its introduction here was the importation of cattle from Southern Angola (Novo Redondo and Benguela), and this has been going on for many years. The Correia Mendes Mission* ascertained, in 1907, that most of the animals from that source arrived at the island already infected, and this continued until quite recently, compelling the present Mission to adopt restrictive measures regarding the importation.

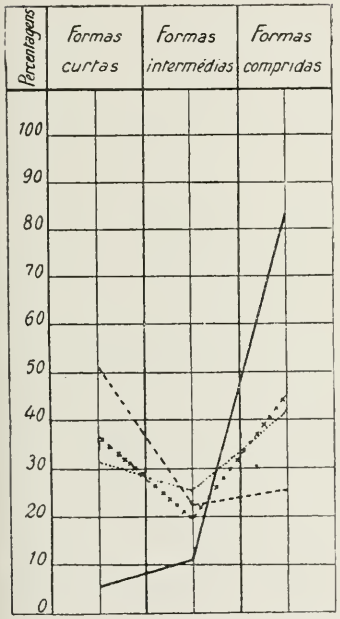
By analyzing the data scrupulously compiled for the Report of the Correia Mendes Mission, the conviction is forced upon one that the parasites studied in the blood of the island pigs in 1906, for which these animals display a complete tolerance, belong to this morphological type. That Mission describes to us as possessed of analogous characters certain trypanosomes of horned cattle, mules, donkeys, and dogs.

Now that we know how great is the variability of the virulence and of the pathogenic aptitude of the parasites of this type, it is easy to interpret the discordance to be seen in the work quoted between the descriptions of trypanosomes of animals carrying a natural infection (in which the *congolense* type is perfectly well marked) and the account of the histology of the blood of the animals used for experiment, especially the rats, where unexpectedly and with startling persistence, we find ourselves confronted with parasites with the long flagellum of the *brucei-pecaudi* type.

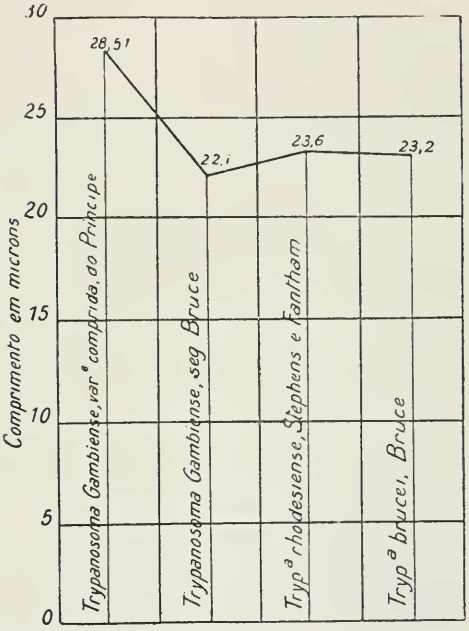
* Correia Mendes, Damas Mora, Silva Monteiro, and Bruto da Costa : "Rapport sur la Maladie du Sommeil à l'Île du Prince," Lisbon, 1909.

CHART XIV.

Comparative Chart of the Groups of Bruce in Four Trypanosomes.



Comparative Chart of Mean Lengths of Four Trypanosomes.

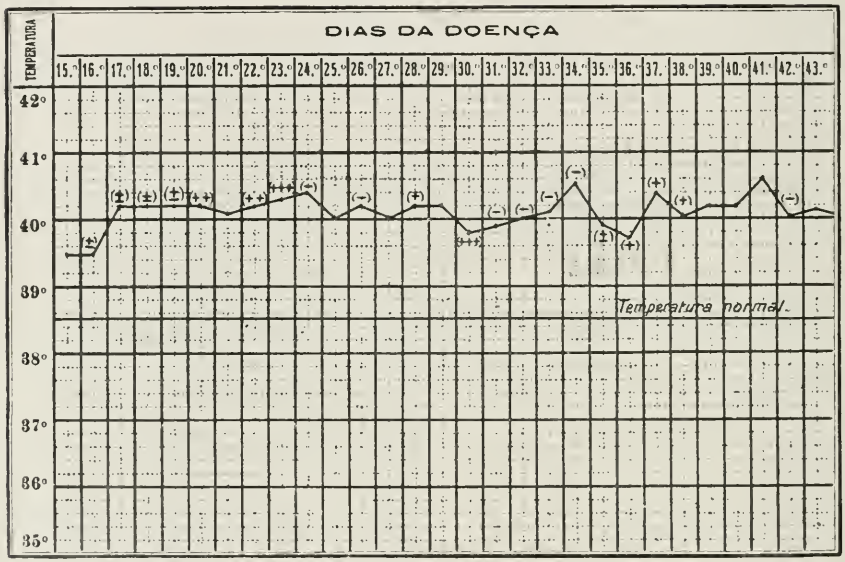


——— *T. gambiense*, var. longa, Principe.
- - - - - - - - *T. gambiense*, Bruce.
..... *T. brucei*, Bruce.
+ + + + + + + *T. rhodesiense*, Stephens and Fantham

Percentagens = Percentages.
Formas curtas = Short Forms.
Formas intermédias = Intermediate Forms.
Formas compridas = Long Forms.
Comprimento em Microns = Length in Microns.
Trypanosoma Gambiense, var. comprida do Principe = *T. gambiense*, var. longa, of Principe.
Trypanosoma gambiense, seg. Bruce = *T. gambiense*, according to Bruce.
Trypa. rhodesiense, Stephens e Fantham = *T. rhodiense*, Stephens and Fantham.
Trypa. brucei = *T. brucei*, Bruce.

CHART XV.

TRYPANOSOMA GAMBIENSE, VAR. LONGA: CURVE OF TEMPERATURES IN MONKEY III.

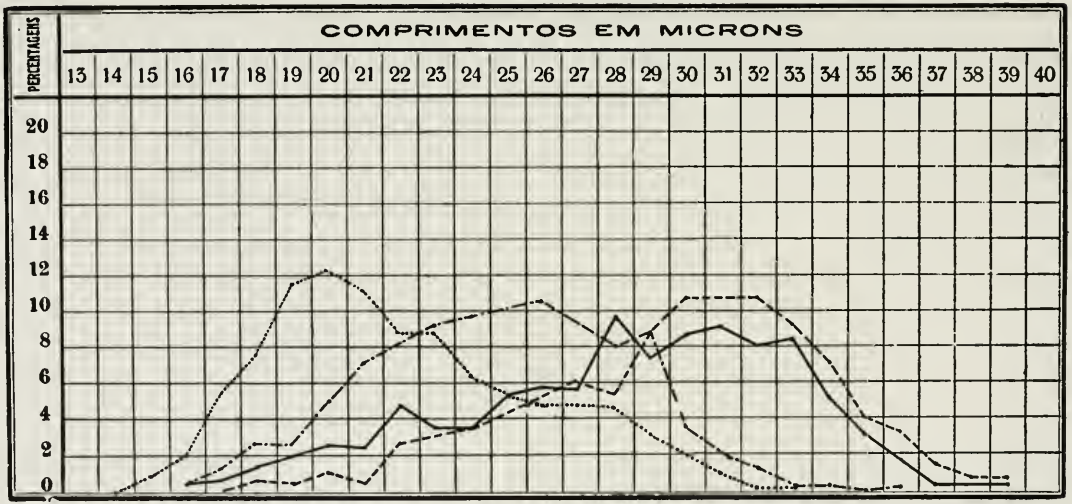


(—) Result of examination negative.
(±) Few parasites.
(+) Some parasites.
(++) A fair number of parasites.
(+++) Many parasites.

Temperatura = Temperature.
Dias da Doença = Days of sickness.
Temperatura normal = Normal temperature.

CHART XVI.

CURVES REPRESENTING THE DISTRIBUTION OF LENGTHS, IN PERCENTAGE, OF THE ELONGATED VARIETY OF THE TRYPANOSOMA GAMBIENSE OF PRINCIPE, AND COMPARISON WITH THE CLASSIC CURVES.



——— Curve of the *T. gambiense*, long variety of Principe, in the guinea-pig } 500 parasites of each
- - - - - - - Curve of the same in the rat } were measured.

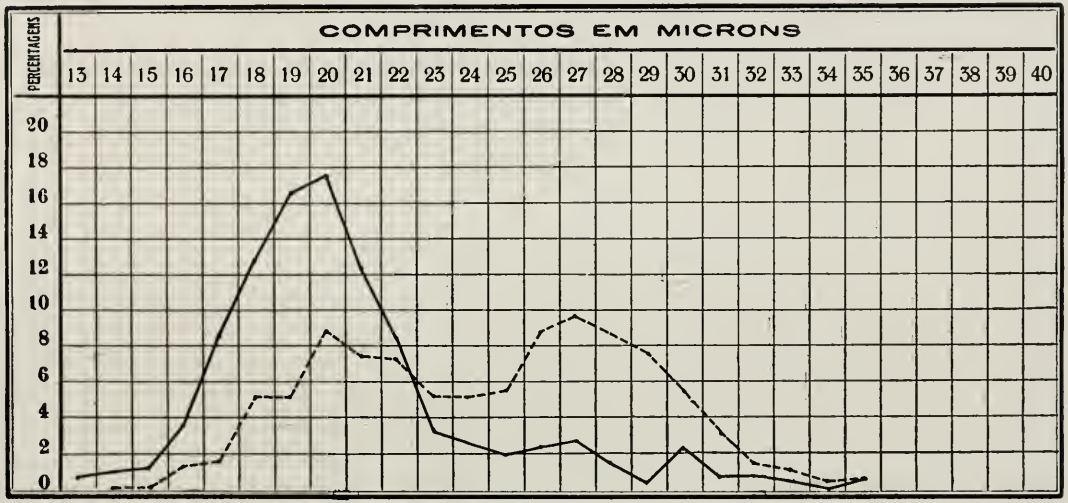
..... Curve of the *T. gambiense*, according to Bruce, Proceedings of the Royal Society, December 8, 1911, B. 572, pp. 327-332.

-.-.-.-.- Curve of the *T. gambiense*, according to Stephens and Fantham, *Annals of Tropical Medicine and Parasitology*, March 31, 1913, vol. vii., No. 1, pp. 27-39.

Percentagens=Percentages. *Comprimentos em Microns*=Lengths in Microns.

CHART XVII.

Curve representing the Distribution of Lengths, in Percentage, of Two Varieties of the Trypanosoma gambiense of the Island of Principe.



——— Curve of the *T. gambiense*, common variety, of Principe, in the monkey } 500 parasites of each
..... Curve of the *T. gambiense*, elongated variety, of Principe, in the monkey } were measured.

Percentagens = Percentages. *Comprimentos em Microns* = Lengths in Microns.

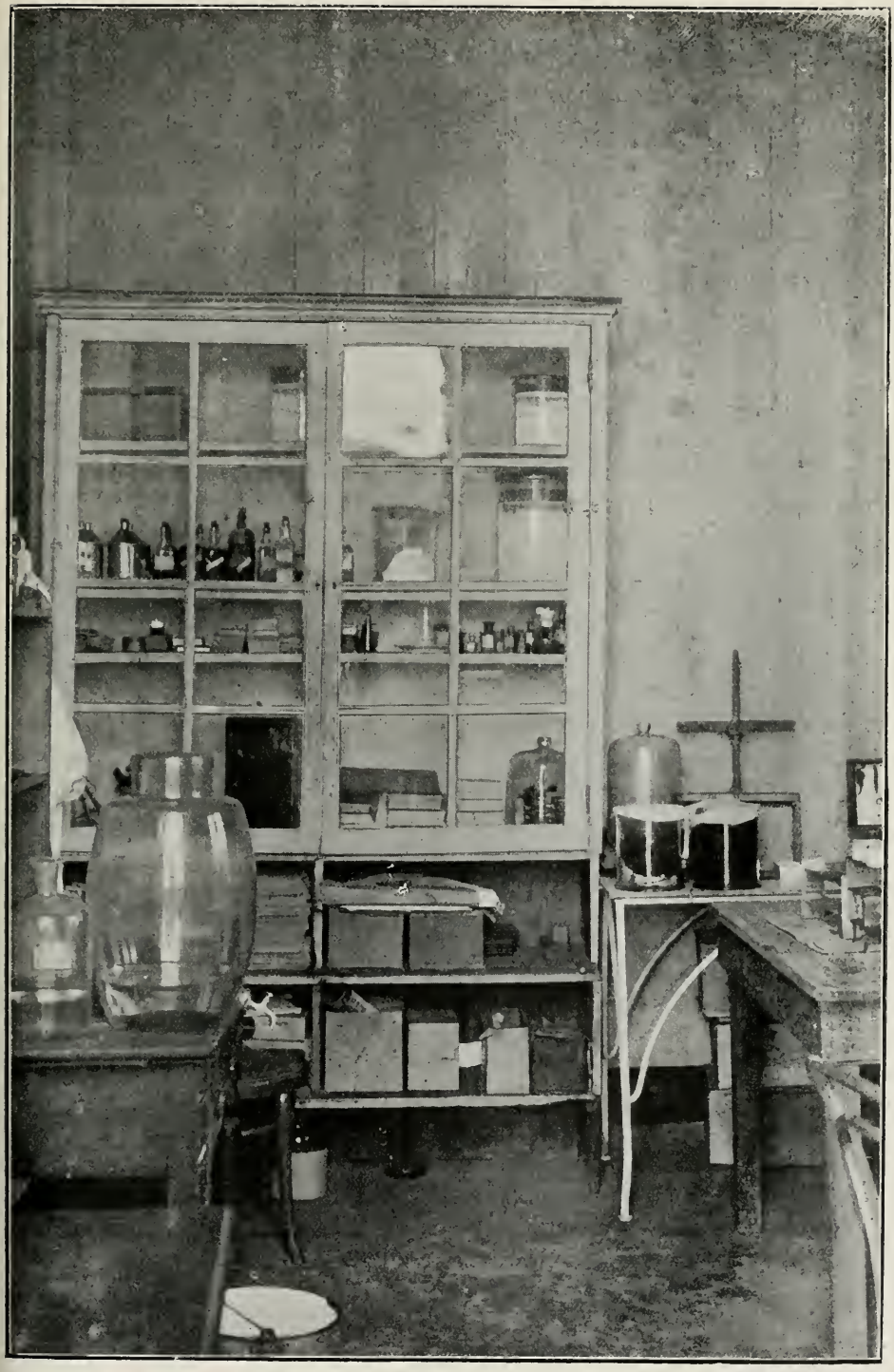


Fig. 67.—First Room for Microscope Work, Principe Hospital.

While the Mission gives us information of a short trypanosome of the *congolense* family in almost all the cases of natural infection, such forms only appear experimentally in rats inoculated with the blood of mules, although mixed with parasites of another kind.

In the short work which circumstances have allowed us to do, it is easily to be seen—in a series of specimens of various origins, which cannot be anything more than varieties of a fundamental species—how great is the variability of which the *congolense* is locally susceptible.

It is natural that the Correia Mendes Mission should have had before it a series of cases of mixed infection, except in the pig, in which the *congolense*, more visible in cases of natural infection, is associated with a second species of the type *brucei-pécaudi*, more difficult of observation in the same circumstances. In the experimental proofs the facts were the reverse, seeing that the laboratory animals, while manifesting an accentuated susceptibility for the latter, only reacted by way of exception to the parasites of the former species.

In 1913 Bruto da Costa* reported the result of experiments made in the island as to the inefficacy of atoxyl in nineteen animals attacked by trypanosomes, and, even in the absence of suitable materials for a retrospective morphological study, he was led to think that many of these infections must have been due to the *congolense*, the almost absolute resistance of which to that medicament has been made prominently known by the labours of Laveran,† Wenyon,‡ and others. Imported, then, from the West Coast, infection by the *congolense*, that of the widest diffusion throughout Africa, constituted a focus in the island of Principe, fed locally by the hordes of wild-pig, and constantly renewed by fresh arrivals of new cases. Even to us, just as the last glossinas were disappearing, there arrived six animals, carriers of the infection, of whom we secured four for the purposes of our study.

The second species that we find mentioned in the Report of the Correia Mendes Mission, lumped in with the first-named under the *probable* designation of *dimorphon* or *pécaudi*, naturally under the influence of the much-disputed characterization of the *dimorphon* by Dutton and Todd, belongs evidently to the family *brucei-pécaudi*, or, according to the view of Yorke and Blacklock, *gambiense-pécaudi*. The latter authors, in their work already cited, upon the classification

* B. da Costa, "Sleeping Sickness in the Island of Principe," pp. 14-28. London, 1913.

† "Trypanosomes et Trypanosomiases," p. 199. Paris, 1912.

‡ *Journal of Hygiene*, 1907, t. vii., p. 273, quoted by Laveran.

of trypanosomes, exclude the *T. brucei* from the family of dimorphic parasites with a long free flagellum, considering it as a monomorphic species, and creating a new name (*T. ugandæ*) for the dimorphic trypanosomes of the Uganda oxen.

The more important characters of the dimorphic parasite studied by the Correia Mendes Mission are, in résumé, as follows:

Morphology.—Forms of two categories were observed: short and broad, and long and narrow.

The short forms measured from 18 to 20 microns in length by 2 to 6 (?) microns in breadth; free flagellum was absent; undulant membrane wide, and its posterior extremity thick and shaped like a very short cone; the micro-nucleus very near to that extremity; nucleus rounded, situated in the central part of the parasite; protoplasmic granulations sometimes present; phenomena of division very rare.

The elongated forms possessed a long free flagellum, and measured between 25 and 35 microns in length by 1·5 to 2 microns in breadth; undulant membrane narrow, with three or four sinuosities; posterior extremity elongated and pointed, the micro-nucleus being distant from it as much as 3 or 4 microns; the macro-nucleus median, elongated in the direction of the axis of the parasite; a great frequency in the figures of division, this commencing at the posterior part of the parasite, first the micro-nucleus, then the flagellum, after that the nucleus, and lastly the protoplasm; the protoplasm was in general homogeneous.

Movements.—More lively in the elongated than in the short forms.

Pathogenic Properties.—The natural infections in the ox, in general mixed, presented in the majority of cases a chronic character, without marked repercussion upon the general condition. In the animals already acclimatized the infection remained latent. The Mission mentions some cases of acute forms.

Evolution comparatively rapid in the horse and mule, the latter animal being also a carrier of mixed infections. Perturbations of equilibrium and weakening have been noticed, with muscular atrophy of the posterior limbs.

In the donkey the advance of the disease is very sluggish.

Infections in the goat, fatal in their termination, showing themselves almost exclusively by the emaciation of the animal.

In the dog, extreme leanness, cutaneous ulcers, ganglionar ingurgitations, and hypertrophy of the spleen; long evolution, with few parasites; cases of spontaneous cure.

In the course of experiments rats showed themselves susceptible, likewise mice, dogs, goats, and a sucking-pig; civet-cats took the infection in the proportion of 1 to 4, and rabbits proved themselves refractory.

The duration of the period of incubation ranged from 5 to 15 days in the rats, and the period up to death was from 23 to 108 days. In autopsy enlargement of the spleen was noticed.

The evolution in guinea-pigs lasted from 4 to 7 months, the number of parasites being constantly low; spleen slightly hypertrophied.

In dogs, a prolonged sickness, resulting in hypertrophied spleen and lymphatic ganglia.

Goats readily took the infection; course of the disease chronic, and parasites easy to find.

No outward signs of infection in the case of the sucking-pig.

A sheep that had been injected died with the usual symptoms of trypanosomiasis, without showing any parasites in the blood and without the latter proving infective to rats.

Having excluded the *brucei* and the *evansi*, we have to keep specially in view, in the retrospective diagnosis of this parasite, the species *pécaudi*, *gambiense*, or an undescribed species.

In its work the Correia Mendes Mission pronounced for the *pécaudi*.

Let us see what are the affinities that the Principe parasite maintains for this species. Its morphological characters in general are analogous; the minimum limit of length in the short forms (18 microns according to Correia Mendes*) is sensibly superior to that ascribed to the *pécaudi* (14 microns according to Laveran, and 12 microns according to Ogawa).†

At the time of the first Portuguese Mission the fact of the existence of forms of posterior nucleus was not known, these forms being analogous to those of the *rhodesiense*, in the species *pécaudi*, discovered in this last by Wenyon in 1912.‡ Hence Correia Mendes does not mention them. As we have been able lately to study three preparations of the blood of the rat, furnished to the present Mission by the School of Tropical Medicine of Lisbon, with the trypanosomes isolated in the

* According to our way of looking at it, the forms of 11·2 to 12·8 microns which the Correia Mendes Mission saw in the rats inoculated from the virus of the mule belonged to a *congolense* species whose existence the direct examination of the blood of these animals had already revealed.

† *Centralb. f. Bakt.*, 1 Abt. Orig., March 15, 1913, vol. lxviii., Nos. 3, 4, pp. 332-334. Cited in *Tropical Diseases Bulletin*.

‡ *Journal of Tropical Medicine and Hygiene*, July 1, No. 13, p. 193.

island in 1907-08, in none of them have we found any forms of this kind.

Under the head of biological reactions, the trypanosome studied by Correia Mendes has, in common with the *pécaudi*, the acute predominant character of the infection of equine species, the absence of clear objective symptoms in the infection of the sheep and the goat, and its slight virulence in the case of swine.

On the other hand, there may be noted the following discordancies: The evolution of the *pécaudi* in the rat is usually much more rapid (19 days as a mean, according to Laveran; 4 days of incubation and 20 of duration, according to Bouffard); the susceptibility of the guinea-pig for the *pécaudi* is constant, according to Laveran and Mesnil, and Bouffard, although the resistance of these animals to infection may be variable; the virulence of the *pécaudi* for the dog is far superior to that shown by the experiments of Correia Mendes in the case of the Principe parasite.

Another fact considered nowadays as of importance in the diagnosis of the *pécaudi*, and one which could not be verified at the appropriate time, consists in the absence of salivary evolution in the glossinas, its carriers, unlike the *gambiense* and the *rhodesiense*, which only confer upon the insect its infective properties after invading its salivary glands.*

The divergencies pointed out lead us to doubt the interpretation, questionable on other grounds, of the Portuguese Mission of 1907-08, and to look for a different solution to the problem. For some time back our attention had been struck by the resemblance between the trypanosome described by Correia Mendes, as represented in the micro-photographs of his work, and the parasite which we had isolated from a patient on the island, described above as an elongated variety of the *T. gambiense*. Comparing one and the other descriptions, it will not be easy to discern between them any appreciable discordance: the high mean length of the first coincides with the exaggerated figures we obtained in our measurements; the chief morphological details, with the differences in the widths of the short and the long forms, the form and situation of the nucleus, situation of the micro-nucleus, etc., are, in the human parasite, the reiteration of what Correia Mendes had seen and described.

* Roubaud, *Bull. de la Soc. de Pathol. Exot.*, June, 1913, vol. vi., No. 6, pp. 435-441.

The study of the preparations of the blood of rats infected by the parasites of oxen and of a mule in 1908, to which we have above made reference, came in to confirm our suppositions as to the perfect identity, morphologically, between these parasites and those which we have considered as constituting an elongated variety of the *gambiense*.

Returning to the morphological detail which has best served us for the characterization of this last, the shape of the posterior extremity and the relative position of the micro-nucleus in the elongated forms, we have ascertained that a similar detail was faithfully reproduced in the parasites of the ox and mule of 1908.

All the modalities of this detail, which we will enumerate over again, are to be found accurately reproduced in the preparations furnished by the School of Tropical Medicine: (1) The elongated and narrow extremity; (2) the same in spatula form, with possible dorsal doubling back; (3) the same in the form of a stout cone; (4) the same in the form of a truncated cone; (5) the same as a short cone with, possibly, the micro-nucleus juxta-posterior.

These and other analogies stand out better from the comparison of the figures shown in the engraving on p. 243, in which we place side by side, the better to judge of them, typical forms of the human parasite of 1914, and other, equivalent, of the ox and mule of 1908, all of them from the blood of the rat and drawn with the same magnification of 2,000 diameters.

For lack of a sufficiency of experimental animals, we have been unable to establish reliable means as regards susceptibility for the elongated variety of *T. gambiense* of the island; but in any case we have ascertained that its pathogenic properties do not widely depart from those of the common *gambiense*. On the other hand, the biological reactions of the trypanosome studied by Correia Mendes—differences relating to guinea-pigs and rabbits apart, for these cannot be regarded as absolute—approach much closer to those of our long variety than to those of the *pécaudi*, bearing in mind the classic descriptions of this last.

All these facts lead us to the conclusion that the dimorphic parasite found by the Correia Mendes Mission in the mammals of the island in 1908 was only a local race of the *gambiense*, which is at present represented in the island by a variety of human parasite of dimensions superior to that of the classic species.

Such a community of parasites between domestic animals and man

may perhaps be explained by the special conditions of the epidemic circumstances of the island, where, along with a prodigious abundance of glossinas and a considerable diffusion of sick persons at large, men and animals were living in permanent contact within a limited area ; and thus the *T. gambiense* was able to adapt itself, better than anywhere else, to the hematic medium of the latter.

As for the species of the family *cazalboui*, and specially the *T. uniforme*, which seems to flourish in certain places on the West Coast, whence the island imports its cattle, we have not found in the Report of the Correia Mendes Mission trustworthy elements for supposing that the infections of this kind had ever created a focus for themselves in the island.

CHAPTER II

HEMATOPHAGOUS INSECTS OF THE ISLAND OF PRINCIPE

The blood-sucking fauna of the island, as far as seen in 1913-14, is not very varied. Now that the *Glossina palpalis* is extinct, the great scourge of the colony for many years, and the breeding-grounds of the Culicidæ have been reduced in number and importance, the most troublesome species that remain, from this point of view, although of little or no pathogenic consequence, are the flies of the genus Stomoxys and the nematocerous Culicoides.

The first-named obtain their food almost exclusively from the blood of the larger domestic mammals, for whom they constitute a veritable scourge, and the last-named are particularly annoying to mankind.

The number of species of Culicidæ that we have been able to get in the island has been rather small, only one anopheles and four culices. It is possible, however, that these insects may have, or may have had, a considerable representation in the fauna of the colony; but the fact remains that, with the sanitation work which has been accomplished in the island, all their permanent nurseries may be regarded as extinct, so that only by accident can they find conditions appropriate to their development. Hence the difficulty of obtaining a reasonable number of samples for collection and classification.

Family Tabanidæ.—We have studied only two species of this family, the *Tabanus congolensis* and the *Tabanus tœniola*.

Tabanus Congolensis.—This is the most abundant tabanid in the island. The fly-catching section of the Official Brigade caught during the months April to June, 1914, a daily average of 25 to 30 insects. This kind is to be found chiefly in the coastal belt of the north and west of the island, frequenting the banks and the mouth of the rivulets that flow into the sea there.

In some thousands of insects we saw only three males.

It does not seem to be a species very keen upon blood, for it is seldom seen in the houses or cowsheds, places where it would most easily find that kind of food. All attempts made in the laboratory with a great number of insects to induce these tabanids to sting the experimental animals were in vain. On the other hand, they greedily drank sugared water, and at other times simply sucked the mud.

Of 200 insects dissected, we found in 9 blood recently ingested, or, say, 4·5 per cent. In the remainder there were no recognizable traces of it.

A certain number contained herpetomonas in the lower gut, especially in the rectal ampola, where we often observed a veritably pure culture of the protozoon. In 200 samples, 23, or 11·5 per cent., were carriers of this intestinal infection.

Besides this parasite, 3 insects contained ferments in great quantity scattered throughout the intestine, 1 presented a ramified mucedinea in the rectum, and 6 some small cysts in the intestinal anterior wall enclosing an embryonic form of some invertebrate, possibly a worm, not identified.

This tabanid is described as existing in the Portuguese and Belgian Congo. In the specimens in Principe the clear lateral zones of the abdominal rings are slightly differentiated, a certain attention being necessary to distinguish them.

Tabanus Tæniola.—This species is much less abundant in the island than the preceding one; still, it appears more frequently inside the houses than the first-named. In 23 insects which we dissected, 12 were swollen with blood, and 6 contained the digested remains of that food in the intestine, which shows the importance of the species as a blood-sucking agent. Experimentally, however, we were unable to get any of these insects to make a meal of blood for us.

In the same 23 specimens, 5 (21 per cent.) were carriers of flagellates in the rectum.

The existence of this species in the island of Principe has already been noticed (E. E. Austen, "African Blood-Sucking Flies," 1903).

Family Stomoxydinæ.—Of this family we only studied a single specimen, which we will now describe.

Stomoxys Nigra.—This is a species of blood-sucking fly extremely abundant all over the island and a terrible worry to domestic animals. It prefers, as victims of its attacks, horses and cattle, and will pursue them over long journeys, following them in positive clouds. When the

animals, especially those of the horse kind, are travelling slowly, the fly seats itself upon them in large numbers, covering a wide space of the skin, preferably on the hind-quarters. Should the animals break into a trot or gallop, the fly takes wing, but does not lose sight of its victim, keeping itself steadily a short way behind or alongside, ready to settle upon it again as soon as the pace slackens.

Its favourite haunts are the surroundings of stables and cowsheds. On the roads generally used for the passage of pack animals, it lies in ambush in damp, shady spots, whence it sallies forth in pursuit of the first beast that happens to go by.

It seldom attacks human beings; when riding, it is only the man's mount with which it concerns itself. During the dry season, from June to September, it becomes scarce and almost disappears.

As it does not as a rule bite in the dark, it has become an established practice in the island to keep the stables dark, and thus give the animals a chance of rest; for the latter, especially horses, tire themselves out quite uselessly in their efforts to rid themselves of so troublesome an assailant.

This species does not seem to play any important pathological part in the island. From October, 1913, to September, 1914, no other species than this came under our notice.

Of 50 flies dissected, almost all of them bloated with blood, 2 contained flagellates in the lower bowel, belonging to the genus Herpetomonas. The study of these will be discussed presently.

Glossina Palpalis.—In another place we give a review of all the facts of importance relating to the life and the part played by this insect in the island. It may now be considered as an extinct species.

The morphological characters of the insect correspond to those of its classical description. As was pointed out in 1907 by the Correia Mendes Mission, its general coloration is rather obscure. Attentive observation reveals the fact that the specimens with the abdomen dark are for the most part males, this obscuration of hue thus corresponding to a sexual differentiation.

The sexual organs of the male are portrayed with sufficient exactness in Newstead's description. The comparison of the drawings obtained by us with those illustrating the work of that author will show a perfect analogy in disposition and conformation of the more important organs; but a slight difference may be noted in the internal edge of the upper claspers, which in the figure given by Newstead

appears rounded, while in the specimens studied by us it resembles a cutting edge, and, moreover, the extension of the dark zone, which stands out from the external margin, and from the vertex towards the internal margin and the base of those claspers, seems greater in the island specimens. Indeed, all the relief of these organs gives us the impression that they are more angular here than the drawings of the work to which we have made reference would lead us to suppose. We would also note as of remarkable frequency the vicious conformation and the anomalies of the distal extremity of the above-mentioned organs, these at one time bifurcating, at others displaying multiple incisions and saliencies of an irregular appearance.

During the months of October and November, 1913, although by then the species had become somewhat scarce all over the island, we were able to dissect 342 flies, 126 of these being males and 216 females, all got from the Roça Sundy; 23 of these insects were swollen up with blood, exclusively mammalian, and in many others pigmentary residue of digested blood was found.

In almost all of these glossinas the existence was observed of a great quantity of bacteria in the thoracic intestine and the anterior part of the abdominal intestine.

In 16 of the insects dissected, or, in other words, in 4·6 per cent. of the glossinas examined, we ascertained the existence of flagellated parasites of the trypanosomic type in the median and posterior part of the abdominal intestine, rare in 3 of them, in fair quantity in 6, and very abundant, forming clumps and rosettes, in 7 of the insects. Their morphological study will be given later.

None of the glossinas dissected showed flagellates, either in the interior of the canal or in the secretory part of their salivary glands; in all of them these organs were carefully separated from the rest of the viscera. In one of them a few free parasites were seen in the interior of the proboscis, but it could not be positively stated that such was their true location when in life.

From among the glossinas afterward dissected, 177 had been put to feed upon laboratory rabbits and monkeys, but these animals remained perfectly clean. For the purpose of these experiments we divided the insects indicated into five lots of 16, 20, 22, 57, and 62 specimens respectively, feeding the first three upon rabbits—these being then the only animals we had available—and the two last lots upon monkeys. Failing living insects in good condition, we were

obliged to suspend these experiments; the flies used were dissected as they died, and in 6 of them we found intestinal flagellates, but in none salivary infection.

Diptera of the Subfamily Culicinæ (*sensu lato*).—Of this great section of the Diptera, abounding in blood-sucking species, we studied in the island 1 *Megarrhinus*, 3 Culicinæ (*sensu restricto*), and 1 Anopheles.

Toxorhynchites (a new species ?).—We only got one male specimen of this insect. Abdomen with orange-coloured and violet iridescence, the former predominating; the second articulation of the tarsus of the posterior feet with a white stripe at the base; the first (metatarsus) and second articulation of the centre feet, both with white basilar stripes; the joints of the tarsus of the fore-feet entirely dark. Among the African species described by F. W. Edwards,* it differs from the *lutescens* in the arrangement of the tarsal stripes, from the *brevipalpis* and the *phytophagus* by these characteristics, and also by the colouring of the abdomen. For these reasons we seem to be dealing with a new species—new at least in Africa.

Culiciomyia Nebulosa.—This is the mosquito of the *Culex* group most frequent in dwellings. Edwards† notes the existence of this species in the island, relying on the study of specimens obtained here by Dr. W. G. Ansorge.‡

Banksinela Luteolateralis.—These are mosquitoes of forest-dwelling habits, living almost exclusively hidden among plants. As soon as any mammal draws near, they surround it at once, directing their attacks preferentially against the lower extremities. They are not very active in their movements, and thus let themselves be easily caught.

We were able to get some specimens of the female. We do not know what are their favourite breeding-grounds. They do not as a rule affect human habitations.

They may be considered the commonest form of mosquito throughout the whole island. The species is one of wide distribution all over Africa.

Stegomyia Fasciata.—This appears to be the sole species of the genus Stegomyia to be found on the island. As is usual, its habits are

* We take as our guide in this short study the articles of F. W. Edwards in the *Bulletin of Entomological Research*, an author who adopts the classification of Lieutenant-Colonel A. Alcock.

† Edwards, F. W., *Bull. of Entom. Res.*, May, 1912, vol. iii., part 1, pp. 1-53.

‡ *Ibid.*, October, 1911, vol. ii., part 3.

diurnal, it frequents dwelling-houses, and stings with extraordinary voracity.

Its larvæ are to be found with the greatest ease in the little collections of water contained in jam-tins thrown out, in empty bottles, in scraps of coco-nut shell, empty cacao capsules, in the clefts of rocks, in the pits prepared for the reception of young cacao-trees, etc. These cacao capsules in particular, thrown into heaps by the planters after their seeds have been collected, form everywhere a fertile repository of the larvæ, giving forth veritable swarms of insects which scourge many parts of the island.

It would be an excellent thing if it were made a general practice to bury the empty cacao capsules immediately the seeds have been removed, as has been recommended by the Medical Mission, instead of leaving them to putrefy in the bad old fashion, with the idea of manuring the surface soil. Thus one of the forms of breeding-ground most prolific in this noxious insect would be put an end to. The insect's presence on the island cannot be regarded with indifference, inasmuch as it constitutes, as is well known, the transmissory vehicle for yellow fever.

Anopheles (Pyretophorus) Costalis.—No other species of anopheles has up to now been recognized on the island. As we know, this is the anopheles most widely distributed throughout Africa.

It belongs to the category of those species whose part in the transmission of malaria has been demonstrated experimentally. All anopheles are equally important in this respect.

Besides the natural swamps, the number of which and their importance are now reduced to a minimum with the extensive embankment and drainage works carried out all over the island, a very dangerous kind of breeding-ground is even to this day created by the pools left in the pits intended for the planting of cacao-trees, opened one year, and left open, as a rule, till the following year. In the rains each one of these pits is a repository of stagnant water. During the *gravana* water only remains in those dug in absolutely impermeable soil, or where the layer of subsoil water has been struck (often at a very small depth below the surface). Sometimes it happens that certain pits, dry a few days or weeks after the beginning of the *gravana* season, end by opening communication, by means of the cracks in the soil produced by excessive evaporation, with springs on the hillsides or with subterranean veins, and appear later on, in the height of the dry weather, freely inundated. We have had occasion to note, perhaps because it

is then that their contents are least liable to be disturbed, that during the *gravana* the pits for cacao become most dangerous as foci of this anopheles.

The shortening of the interval between the opening of the pits and the planting of the trees, a modification of the usual agricultural process the inconvenience of which would seem of minor importance, should bring about a considerable benefit in the matter of hygiene, to the great gain of the labouring population, and at the same time to the profit of the agriculturist himself.

Culicoides Milnei.—The careful and minute study of the pattern on the wings of a tiny *culicoides* abounding in the island of Principe leads us to adopt this classification. The species *milnei* was first described by Austen as a native of British East Africa and Uganda; but finally the same author identified a local variety of the same in Southern Nigeria, differing from the typical examples in its smaller dimensions and by a modification in the arrangement of the light-coloured spots of its wings.

The specimens of the *C. milnei* of Principe seem to belong, in virtue of their small dimensions, to the Nigerian variety.

These insects are commonly known by the name of *melgas* (gnats). They abound all through the island during the rainy season, being most numerous beside the brooks and streams whose current is rapid. It has not been possible for us to locate their larvæ, although we have tried more than once to do so.

Their species is a nocturnal one in habits. During the day the insect may be readily discovered at rest in the interior of dwelling-houses, in the darkest corners, behind furniture and pictures, hidden in the garments hanging in the cupboards, etc. From its small dimensions and the absolute motionlessness it maintains until nightfall, it may easily pass unnoticed, giving the impression of a tiny spot of dust or fly-blow such as the domestic house-fly is in the habit of dropping on the walls.

Its nocturnal attacks are one of the most exasperating inflictions one can well imagine; its sting is excessively itchy, and for some hours after leaves an erythematous aureola around the point stung, similar to that produced by a bug-bite. The same insect will sting in different places, its favourite spots being the backs of the hands, the wrists, the forearm, the dorsum of the foot, and the ankles; sometimes it will also sting one in the face.

Besides those insects which take up their abode in the houses, a

great number invade them at night, some perhaps attracted by the light, passing easily through the meshes of 1 square millimetre, the customary net used for protection against malarial mosquitoes. In some persons the sting of this insect gives rise to an eruption of little itchy papulæ, which afterwards desquamate, and are often mistaken for itch; the natives of Cabo-Verde give it the name of *coceira* (tickling or itching). This eruption is commonly found in newly arrived blacks, not yet acclimatized, who sleep in native lines (*sanzalas*), where this nuisance is much in evidence.

In order to drive away the insect, it is the practice in those places to burn, inside the rooms, substances producing clouds of an active and suffocating smoke having insecticidal properties. The material most commonly used for this purpose is the kernel of the fruit of the oil-palm (*dem-dem*), broken and thrown on the embers. The operation takes place at sunset, inside the sleeping-rooms, with the windows open, these being closed soon after for the smoke to smother the insects that have not made good their escape. The smoke from the burning of these nuts has an intolerably sickening odour, and no doubt properties insecticidal as well. But, all the same, the process defeats its own end, for the atmosphere of the room thus treated remains so irrespirable that nobody can sleep in it without opening the doors and windows, and its ventilation thus admits a fresh invasion of insects, these passing easily through the mesh of the gauze wire netting.

The mosquito-curtains of the beds require to be of a close texture; the tulle usually employed as a defence against Culicidæ is of no avail whatever against the Culicoides. In the places most infested by this plague, peaceful sleep is only possible to people who possess and are able to make use of a mosquito-curtain of closer-woven mesh or of muslin.

In the dry season, as soon as the streams and rivulets slacken off in their flow or cease to run, the species becomes scarce in the island, and disappears even from the places where throughout the rains it was most abundant.

Heteroptera (Blood-sucking).—Although we directed our special attention to this quarter, we found it impossible to discover a single species of the family Reduviidæin the island during the period of our stay. The Heteroptera which we collected belong to the following families: Berytidæ, Heniocephalidæ, Coreidæ, and Lygæidæ. These all belong to species exclusively phytophagic. One of these insects, belonging to the family Coreidæ, was a carrier of an intestinal infection by flagellates.

CHAPTER III

INTESTINAL FLAGELLATES OF THE GLOSSINA PALPALIS IN PRINCIPE

The trypanosomic forms found in the intestines, median and posterior, of the glossinas of Principe may be supposed morphologically to belong to three categories:

1. Long and narrow trypanosomes, measuring between 28 and 38 microns in length, with the posterior extremity elongated and pointed.

2. Forms of medium length, of 18 to 25 microns, broad, with a dense protoplasm, and the posterior extremity as a rule short and thick.

3. Forms measuring between 14 and 20 microns, with the aspect of parasites of the blood of mammals, belonging to monomorphic species.

In none of the insects examined did we discover forms in Crithidia, similar to those of the ancient *T. grayi* which Koch and Kleine held to belong to the evolutionary cycle, in the fly, of a trypanosome of the crocodile; nor did we observe the cysts of propagation seen by Minchin.* As is known, crocodiles are not to be found in this island.

The more elongated trypanosomes are characterized by the sinuosity of their flagellum, by the narrowness of their undulant membrane, and by the elongation of their posterior extremity, which almost always ends in a fine point. In these forms the distance from the micro-nucleus to the posterior extremity measures between 5 and 8 microns. The more slender forms take on only a rose coloration. In some of them there appears to be a small part of the flagellum free. The nucleus is almost always granular, and shows itself much deflected towards the posterior part of the parasite, approaching more or less to the micro-nucleus; the latter in no case is anterior to it.

This category of flagellates (Figs. 1, 2, 3, 5, 6, 7, and 11, Plate IV.)

* Bruce, Hamerton, Bateman, and Mackie, Proceedings of the Royal Society, 1911, t. lxxxiii., p. 513. Quoted by Laveran.

appears to include many of the forms represented by Bruce as belonging to the intestinal evolution of the *T. gambiense* in the *G. palpalis*, seen by these authors and their collaborateurs to have appeared in 8 per cent. of the flies placed in conditions favourable to infection. The longest are similar to those which Miss Robertson* considers as destined to invade the salivary glands after they have passed through the proventricule and the hypopharynx.

Kinghorn, Yorke, and Lloyd,† also note the presence of narrow, elongated forms, pallid in colour, with the nucleus diffuse and having a free flagellum, in the intestinal evolutionary cycle of the *rhodesiense* in the *G. morsitans*. The plate in the work of these authors, which we have been able to consult, does not itself contain these forms.

We have noted, among the elongated forms of our preparations, some narrower, taking a slight rose coloration (Figs. 1, 2, and 6), and others thicker, taking on distinctly a blue colour, and showing in the fresh state movements less active than the first (Figs. 3, 5, 7, and 11). They suggest by their morphological characterization the sexual differentiation pointed out by Koch in 1909 in the intestinal flagellates of the glossina, an interpretation nowadays rejected almost unanimously by the authors who have devoted themselves to the study of this matter. It is true that midway between the two extreme types intermediate forms are to be found without apparent sexual characterization, and that we have not observed phenomena of conjugation between the flagellates supposed to be of opposite sexes.

The multiplication of these flagellates of the glossina is effected by successive binary divisions, leading to the formation of rosaceæ of segmentation, with the flagella directed towards the central part of the heap of parasites. Bipartition is as a rule unequal, as in the cultures. Contrary to what is observed in the blood of vertebrates, the division of the macro-nucleus precedes as a rule that of the micronucleus, as well as the duplication of the flagellum. The phenomenon begins with the nucleus, and only after the two nuclear halves have shown a certain distance between them do the division of the protoplasm and the separation of the daughter-forms take place.

The plan of nuclear division is transversal, and the line of separa-

* "Notes on the Life-History of *T. gambiense*," etc., Proceedings of the Royal Society, December 17, 1912, series B., vol. viii., No. B. 584, pp. 66-71. Cited in *Tropical Diseases Bulletin*.

† *Annals of Tropical Medicine and Parasitology*, June 10, 1913, vol. vii., No. 2, pp. 281, 282.

tion of the new parasites, drawn in the space included between the two secondary nuclei, being oblique, is perhaps more transversal than longitudinal, which is in accord with the affirmation of Miss Robertson, who considers the type of division of the forms of intestinal evolution of the *gambiense* in the *G. palpalis* as " practically transverse."

By this process the resulting parasites are sensibly unequal, the anterior being especially constituted by the protoplasm of the anterior part of the primitive trypanosome, and the posterior by its median and posterior part. The first, corresponding to the narrowest and most elongated part of the original form, will result in placing its nucleus very close to the posterior extremity; formed at the expense of the most voluminous protoplasmic mass of the mother parasite, it will be the bigger, and will have the nucleus approximately median in position. Thus may be explained the dimorphism in which some authors wish to discern a phenomenon of sexual differentiation.

Figs. 9, 14, 17, 25, and 30, of Plate IV., show some of the forms of multiplication observed by us.

We frequently find rounded or ball-like forms in the glossinas carrying flagellates. The genesis of these forms appears to us similar to that which takes place in the multiform circumstances in which the trypanosomes of vertebrates assume this aspect, inside or outside the organism of their host. As a general rule there first occurs a phenomenon of curling-up, followed by fusion of the protoplasm into a compact mass; but there may meanwhile be excluded from this metamorphosis, at one time the anterior extremity of the trypanosome, at another the posterior, or even both together. The volume of the rolled-up body resulting will thus be greater or less according as it contains or does not contain the micro-nucleus.

Many of these round forms fall into degeneration, and then there is observed a blotting-out and fragmentation of the nuclear masses, and the transformation of the protoplasm into a weak and dim reticule of coloration.

The duplication of the nucleus in some of these forms seems to have nothing to do with the phenomena of actual multiplication, but only to indicate that the original flagellum was in process of division; in the insect, as in the vertebrate, the multiplicative function is an attribute exclusive of the flagellated forms.

In the coloured preparations of one of the glossinas examined there was observed, with some frequency, the phenomenon exemplified in

Fig. 68.—Second Room for Microscope Work, Principe Hospital

Fig. 10, Plate IV.: a trypanosome in process of evolution towards the production of a globular form, seemingly in conjugation with a flagellated parasite. We interpreted such an arrangement as produced during the normal segmentation of the flagellate, in which one of the daughter forms, before its complete separation from the other, may have taken on the rounded form. In this fly the intestinal parasites were extremely abundant, and in it were to be found the most varied involutionary states, some of which are reproduced in the same plate.

The phase reproduced in Fig. 4 reminds one of a cyst form; the supposed involucre is not really more than the flagellar embroidery of the undulant membrane placed on its periphery. The trypanosome which gave rise to this spherical form was in process of division, which explains the presence of two nuclei.

Figs. 24 to 28 correspond to broad trypanosomic forms, with abundant protoplasm containing a variable number of vacuoles, almost all in process of division. The obtuse shape of the posterior extremity in many of them is a point to be noted.

The undulant membrane, although narrow and but little sinuous, is sufficiently distinct. The process of segmentation, usual, binary, and unequal, approximately transverse, is perfectly exemplified in some of them.

There is no free flagellum; the position of the nucleus is median.

It would be interesting to know to what extent these and other forms are related to the species affecting the blood of vertebrates transmitted formerly by the glossinas of the island; but the non-success of our attempts at inoculation by means of these agents, captured in the region, has made any such identification impossible.

We reproduce in Figs. 18 to 22 the trypanosomes of the intestine of the glossinas most closely approaching the type of the vertebrates; the carrier-fly in our register bore the number 195. Some of these could hardly be distinguished from certain forms of *congolense* in the blood of the mammal host; their length gave us dimensions between 14 and 20 microns. These forms, like the remainder described, lived only in the intestine of the insect; their numbers were small.

Roubaud, describing the intestinal forms of the *congolense* in the glossina, ascribes to them an undulant membrane well developed. On the contrary, in this category of parasites which we have just described, that organ is rudimentary, in which respect they approach the sanguicolar forms of that species.

CHAPTER IV

TRYPANOSOMATA OF THE TABANIDS OF PRINCIPE—A PROBABLE NEW SPECIES OF HERPETOMONAS

In both the species of tabanids studied in this island we ascertained the presence of intestinal infections through herpetomonic forms continually localized in the rectal ampulla and neighbouring part of the lower bowel.

As it is usual to find the free forms of flagellates of insects in the median intestine of their host, and the fixed forms, as well as the resistent ones, in the rectum, it happens that in this *Herpetomonas* of the Tabanus of Principe both one and the other forms have their principal domicile in the rectal ampulla, whence they invade a limited portion of the posterior intestine.

In the designation of Herpetomonas we include the former genus *Leptomonas*, seeing that the duplication of the flagellum upon which the distinction of genera was based seems to us interpretable as a stage in the multiplicative process of the protozoon.

In life, by crushing the rectal ampulla of an infected insect between a slide and cover-glass, we see the little parasites accumulated in great masses more or less irregular, fixed mostly to the intestinal wall, between the rectal papillæ, these arranging themselves with the flagellated end directed towards the centre of the colony. The infection invades the whole ampulla up to the anal opening, and from behind forward it does not go beyond the constriction of the colon adjacent to it. In the insects, carriers of the flagellate, the rectal ampulla shows itself dilated and full of a turbid liquid.

The movements of the free forms are better observable by diluting the masses of parasites in serum and making the examination of the emulsion between slide and cover-glass or in a suspended drop. They detach themselves and move about with the flagellum in front, travelling in straight lines, and often changing their direction. From time

to time they suspend their course to turn on their flagellum in every direction, round about the point where they station themselves, and then resume their movement.

The method by which we have been able conveniently to study the morphological details of this flagellate in stained preparations consisted in mixing a drop of physiological serum, containing numerous parasites in suspension, with a drop of rabbit's or rat's blood, and spreading this mixture out in the ordinary way with thin preparations of blood; we then coloured it by the Leishman process, or we fixed it with absolute alcohol so as to stain it afterwards with the Giemsa mixture. The direct colouring of the smears by either of the two stains, with or without fixation, always gave us inadequate results, the flagellates remaining invisible.

Ordinarily, both in the *T. tæniola* and in the *T. congolensis*, we were able to distinguish the three categories of the froms of Chatton and Léger: free or monadic forms, gregarinic forms with the flagellum for the most part reabsorbed, and cyst forms or forms of resistance.

For the sake of greater clearness we will describe in the first place the forms of the gregarinic series and the states of encystment, leaving to the last the monadic forms, more complicated in their evolution.

1. **Gregarinic Forms.**—The shape of these forms is generally ovoid, larger at the posterior than the anterior part; sometimes they are pyriform, the narrow part anterior. When in process of multiplication they have a tendency to a globular form. They measure 5 to 7 microns in length by 2·1 to 3·5 microns in breadth across the nucleus in the simple forms, reaching 5·5 microns in breadth in the forms of division, being then approximately spherical.

The coloration of the protoplasm is blue in the posterior part, and carmine in the anterior, with transitional shades in the intermediate zone. The nucleus is situated in the median part or in the posterior portion of the parasite; the micro-nucleus is at times anterior, at times approximating somewhat to the macro-nucleus, in juxtaposition to it at others; yet in this group of forms we did not discover any parasites with the micro-nucleus posterior to the nucleus, or the trypanoids of Chatton and Léger.

In the simple forms the micro-nucleus takes the form of a cross-staff, and is approximately transversal; in parasites in process of division it presents itself under the aspect of two little dashes forming an angle, the opening of which is towards the anterior part. The

macro-nucleus is in general more or less rounded. The time at our disposal did not allow of our studying its inner structure, for which we should have required preparations fixed by the moist process.

The flagellum in the simplest cases is single. It rises a little in front of the micro-nucleus out of a rhizoplastic sheaf visible in some figures. Its course inside the parasite is more or less short, according to the position of the micro-nucleus, and describes almost invariably a single curve, the concavity of which is turned towards the lateral margin of the protoplasmic outline to which the micro-nucleus more closely approximates itself. It happens, indeed, that the latter moves itself away, as a rule, from the median line, getting nearer to one side than to the other. The length of the flagellum is very variable, being in any case always but little elongated. On rare occasions does it attain the length of the protoplasmic part, as it may only measure 2 or 3 microns, or be wanting entirely in the precystic forms, as, for instance, in those reproduced in the group of figures, Plate V., No. 13. Sometimes the reabsorption of the free part of the flagellar apparatus is indicated by the presence of protoplasmic residua close to the anterior extremity of the parasite.

In certain cases the flagellum seems to have a duplex origin, and to result from the union of two filaments, one starting from the micro-nucleus, and the other directly from the macro-nucleus, these, at a short distance within the body of the flagellate, converging into a single appendix. The flagellar apparatus may also be double, and then the existence of two flagellates may be observed, one springing from the micro-, the other from the macro-, nucleus. This is an arrangement the sequel to that of the biradicular flagellate, the second flagellum being naturally destined to pass into one of the daughter-forms on the occasion of division, seeing that in these protozoa, as perhaps besides in all the binucleated forms, the flagellum does not take part in the process of segmentation.

In these forms the division is binary, equal, and longitudinal, having as its result either the micro- or the macro-nucleus of each of the daughter-forms of bipartition of the corresponding organs of the mother-parasite. Only the flagellum of one of the secondary forms has an independent origin, and seems to have the value of a nuclear production of the primitive form.

The approximation between the macro- and the micro-nucleus, both of which may remain in contact, corresponds to the *spermoid*

states of Chatton and Léger, and has the significance of a preparatory phase of cystic productions.

In Figs. 1 to 13, Plate V., the chief types of this *Herpetomonas*, which we consider as belonging to the gregarinic series, will be found reproduced.

2. **Cystic Forms.**—The derivation of the resistent forms of this parasite may take place either from the ovoid forms of the gregarinic series or from the monadic forms; the former is, however, the more frequent case.

The general form observed in these cystic states depends upon the shape of its primitive forms, ovoid or pyriform when the former hypothesis holds good, the commoner of the two, but elongated when the latter is the case.

These cystic forms may be easily distinguished by their possession of a thick eosinophil involucre, or, rather, by their taking on a carmine coloration, the arrangement of which differs according to the phase in which they may find themselves. So long as these cysts remain adherent to the wall of the rectum, their involucre presents an orifice at the anterior pole, through which a protoplasmic digitation projects itself, apparently the residuum of the free flagellum of the anterior form, its function being that of an organ of fixation. The thickness of this capsule is not uniform; its greatest width is to be found in the anterior portion, round about the polar orifice, and diminishes gradually front to back, so that, in the cystic forms not far advanced in their evolution, the revestment of their posterior part will be found reduced to a thin lamina. The measurement of its thickness round about that orifice may attain 1·5 microns, while on the opposite side it will only be 0·1 or 0·2 micron.

When they attain complete maturity, as it is probable that only then are they fit to pass into the exterior medium and act as agents of propagation, their involucre becomes complete, takes on a uniform thickness, and its outline rounds itself so that the shape of these definitely cystic forms is more or less globular or even spherical.

The structure of this involucre, after attaining its proper consistency, which we may call cellulose, shows itself to us as striated in a radial direction. In the definitive forms there seems to be an internal layer in direct contact with its protoplasmic contents, denser, and another equally dense in the periphery, between the two there being a zone of lighter colour. Ordinarily only the first layer—that of

greater density—is clear, the exterior outline of the capsule being ill-defined.

The differentiation of the cystic capsule occurs from front to back, beginning close to the flagellum of the original parasite, and in the direction of its thickness, from the inside outwards. This explains the diversity of aspects which it may present to us.

Not all the cystic forms succeed in fulfilling their rôle of spores of contamination. Many degenerate within the original carrier, this being manifested as a metamorphosis by the loss of structure in their enveloping capsule, which becomes homogeneous, and by its weak coloration, which from carmine turns rose-coloured. In a more advanced phase of the process its protoplasmic contents lose their regularity of outline, and assume an amœboid arrangement, in which they are accompanied by the substance of the former capsule, now become malleable.

As we have already pointed out, the micro-nucleus of these cystic forms is always more or less close to the nucleus-in-chief, at times in juxtaposition to it. The intraprotoplasmic part of the flagellum is almost always recognizable.

3. **Monadic Forms.**—In this *Herpetomonas* we have not found acicular forms, properly so called. The forms belonging to this category are distinguishable from those of the gregarinic series by being as a rule longer and a little narrower than these, by their approximately fusiform shape, by almost always terminating in a point at their posterior extremity, instead of presenting this extremity wide and rounded as in those of the same series, by the greater length of their flagellum, and, moreover, by their method of division, very different from what we have described above when treating of the gregarinic forms. There are to be noted further, in the monadic forms of this *Herpetomonas*, characters of sexual differentiation, a matter which is up to the present day much disputed in the history of these flagellates, but which we are in a position to settle in the affirmative, as we have been able to observe well-marked figures of conjugation.

The length of these forms measures between 7·5 and 10·5 microns, and their breadth between 1·1 and 3 microns. The length of the flagellum may reach 11 microns. This is often difficult to observe throughout its total length, for its terminal part as a rule colours badly.

The form of the nucleus is circular or oval. Sometimes it is considerably elongated in the direction of the major axis of the parasite.

Its situation is median or posterior. The micro-nucleus is linear, or cross-staff, transversal; it may be slightly curvilinear, with the concavity anterior, or may seem made up of two granules, an appearance which has nothing to do with the phenomena of division. Sometimes it is placed in the anterior part of the parasite, at others in the median part, and then it may be anterior to the nucleus or beside it. The tripanoid forms are the rarest, and represent generally the feminine type.

The process of division in these monadic forms comprehends many very original phases. In the first place, the bipartition of the body of the parasite is not, properly speaking, longitudinal, nor yet transversal, but really follows an oblique plane in space, cutting both the superior and inferior as well as the lateral faces, at points reunited by oblique lines and never perfectly opposite. From whatever side one looks at the parasite, the plane of cleavage is constantly bisected.

The final separation of the daughter-forms is accomplished, at one time by slipping in the inverse direction to the length of the major axis of the primitive form, at another by rotation in the opposite direction to its extremes, so that a moment may come at which, in the last case, the two daughter-forms cross one another in X or in V form before they separate definitely. The division of the macro-nucleus comes about similarly according to a bisected plane, and the moving apart of its two halves also by a motion of rotation or of translation.

Neither the micro-nucleus nor the flagellum of one of the daughter-forms appears to have any relation with the corresponding organs of the original parasite. To judge by the transitory phases reproduced in Figs. 21 and 22, one of the micro-nuclei originates in the primitive macro-nucleus, and the corresponding flagellum is, as usual, a fresh formation. Figs. 24 to 34 place in evidence the remaining aspects of the march of the process up to its final term.

The flagellated extremities of the young parasites at one time remain on the same side, at another on opposite sides, according to the direction in which the micro-nucleus of the new formation separates from the macro-nucleus of the primitive one, and according to the process of splitting-off of the two daughter-forms. The most general case consists in the production of the new micro-nucleus at the expense of the posterior part of the original nucleus, almost always before the bipartition of the latter; so that there is a stage when the parent parasite presents to us a medium nucleus and two micro-nuclei, one in

its anterior, the other in its posterior, part, that which occupies the latter position being the most recent, and one or two flagella.

Other hypotheses may arise, and one of these is that the separation of the micro-nucleus of the new formation may be made laterally, as in the case exemplified in Fig. 26.

The heterogamia of this parasite makes itself very visible by a comparison of Figs. 18 and 19 with Figs. 20 and 23. The forms of the female may be readily distinguished by the greater breadth, by the dark blue colouring of their protoplasm, and often by the presence of chromidiæ and reserve substances. It is possible to distinguish them easily from the forms of the gregarinic series by their fusiform outline, whereas in the latter the ovoid form predominates.

In the feminine forms the micro-nucleus is to be found with some frequency in the proximity of the macro-nucleus; the tripanoid forms belong exclusively to this category of gametas. What the part represented by this approximation in the genesis of such a sexual differentiation may be, is not easy to tell.

Among the forms of feminine characterization and others of discoloured protoplasm, with the flagellum longer, there is a process of protoplasmic fusion, accompanied by certain modifications on the part of the nuclear system, which to our mind cannot be other in signification than those of a phenomenon of conjugation. Figs. 35 to 37 show clearly progressive phases of a phenomenon of this order. In Fig. 36 may be seen small masses of nuclear origin, close to the periphery of the feminine *gameta*, with the appearance of polar globules in process of expulsion.

In Fig. 37, in which the phenomenon of copulation almost reaches its end, the difference is well marked as regards the chromatic richness of the nuclei of the two *gametas*, greater in the male *gameta*, in contraposition to the density of the protoplasm, greater in the female form.

What will follow the fusion of the two *gametas?* It does not appear to us that it can be the point of departure for a special cycle. As occurs in other protozoa, the conjugation of forms sexually differentiated will only have for its object the continuation of the process of binary division, which will tend to become difficult, at the end of a certain number of generations, by the progressive aging of the original protoplasm. The fusion of two parasites, having acquired, by rest and in virtue of special nutritive processes, new qualities of resistance and vigour, will produce a rejuvenated monadic form, without which

the perpetuation of the parasite in a given host would probably become impossible.

From what we have written here, and from the appreciation of our explanatory figures, we believe we have demonstrated the existence of phases of sexual differentiation and of forms of true conjugation in the evolutionary cycle of this flagellate, a parasite of the tabanids of Principe. This little work of ours will thus be a modest but interesting contribution to the still obscure natural history of the binucleates.

In the different specimens of tabanids dissected, there predominated in general the forms described as belonging to the gregarinic series, almost always accompanied by a lesser number of monadic forms. Only one of the insects, in which the coloration of the preparations remained perfect, showed a number of monadic forms superior to that of the former. It was in this one that we studied the phenomena of conjugation described.

The number of cysts contained in the rectum was in some cases amazing; in others they were rare or even absent. We did not notice any case of exclusively cystic infection.

Herpetomonas of the Stomoxys Nigra.

The proportion of Diptera of this species, carriers of flagellates in the island, does not appear to be over 4 per cent. Their localization in general is in the lower intestine.

In two specimens of fly dissected, carriers of infection, we found neither cysts nor gregarinic forms properly so called. We only saw free or monadic forms, with long flagellum and elongated profile, showing in general signs of division. Some of these free forms tend to assume a spherical shape. We often found involuted forms.

Figs. 39 to 43 exemplify the principal modalities of this parasite.

The duplication of the flagellum appears constantly to be part of the mechanism of division.

We saw no acicular forms.

Recently Macfie* has called attention to the high frequency of herpetomonic forms in the intestinal tube of the *Stomoxys nigra* after the insect had been sucking the blood of animals infected with the

* "Preliminary Note on the Development of a Human Trypanosome in the Gut of *Stomoxys nigra*," *Annals of Tropical Medicine and Parasitology*, November 7, 1913, vol. vii., No. 3 B., pp. 359-362.

human trypanosome of Nigeria. On the contrary, the control flies, whether caught as adults or born in the laboratory, showed themselves always free from them. The results of these experiments, the reach of which in practice may be considerable, have not, however, been confirmed.

Flagellates of a Hemiptera.

In the milky contents of the stomach and intestine of a Hemiptera of the family *Coreidæ*, we have seen numerous flagellates of the genus *Herpetomonas*, representative of various phases of evolution of one species, from the long acicular forms down to the cystic forms.

The examination of the latex of some kinds of Euphorbiaceæ of the island has not led to the discovery of flagellates proper, but the subject cannot be considered as definitely settled, for we limited ourselves to summary observations. The *Herpetomonas* of this insect seems to us to be in any case different, both from the *Herpetomonas* (*Leptomonas*) *davidi* of Lafont and from the *H. lygæi* of Patton.

Postscript.

After a clinical inspection of the whole of the estate hands and establishments, made in September, 1914, by the Medical Mission, we found 175 individuals with more or less tumefied cervical glands. All were submitted to examinations of their blood by the thick preparation process, and 92 of them, whose ganglia were of suitable volume, to examinations of the ganglionar liquid, two cases of infection being discovered, not registered, by the latter process, one in a Cabo-Verde native, and the other in a native of Angola, both with a residence in the island of approximately of four years.

THE MEDICAL MISSION.

Principe,
September 25, 1914.

PLATE I.

Comparison of Three Trypanosomes of Different Origin.

Figs. 1 to 11. Trypanosomes of human origin in the rat: year 1914.

Figs. 12 to 21. Trypanosomes of the bovidia in the rat. Preparations made by the Correia Mendes Mission in 1908.

Figs. 22 to 29. Trypanosomes of the mule in the rat. Preparations made by the Correia Mendes Mission in 1908.

Figs. 1, 2, 12, 13, 22, and 23. Long forms, with the posterior extremity elongated and pointed.

Figs. 3, 4, 14, 15, 24, and 25. Long forms, with the posterior extremity spatulate.

Figs. 5, 16, and 26. Long forms, with the posterior extremity in a thick cone.

Figs. 6, 17, and 27. Long forms, with the posterior extremity thick and truncated.

Figs. 7, 8, 9, 18, 19, 28, and 29. Intermediate forms.

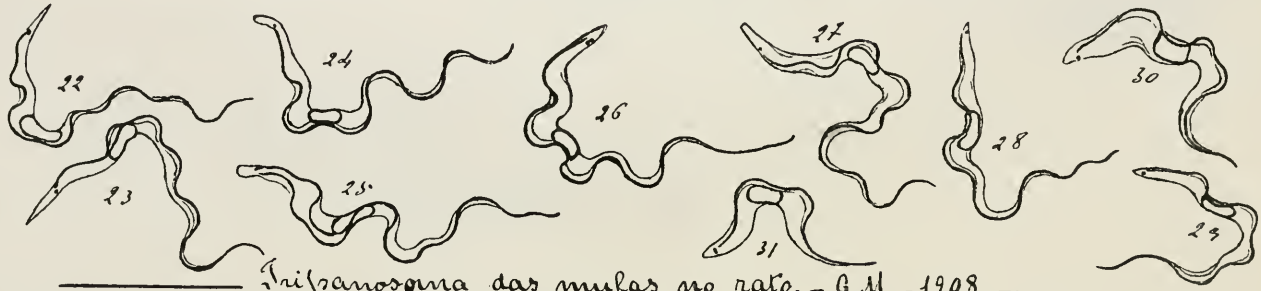
Figs. 10, 11, 20, 21, 30, and 31. Short thick forms.

Magnification, 2,000 diameters.

Gravura comparativa de tres Tripanósomas de origem diferente

Tripanosoma humano no rato. – 1914.

Tripanosoma dos bovideos no rato. – C. M. – 1908.



Tripanosoma das mulas no rato. – C. M. – 1908

PLATE II.

Genital Armature of the Male *Glossina palpalis* in Principe.

A. Ventral view of the whole.

1. Superior claspers.
2. Inferior claspers.
3. Connective membrane of the upper claspers.
4. Bladder.
5. Sheath of the penis.
6. Editum.
7. Harpes.

B. Anomalies observed in the superior claspers.

C. Inferior claspers highly magnified.

Plate II

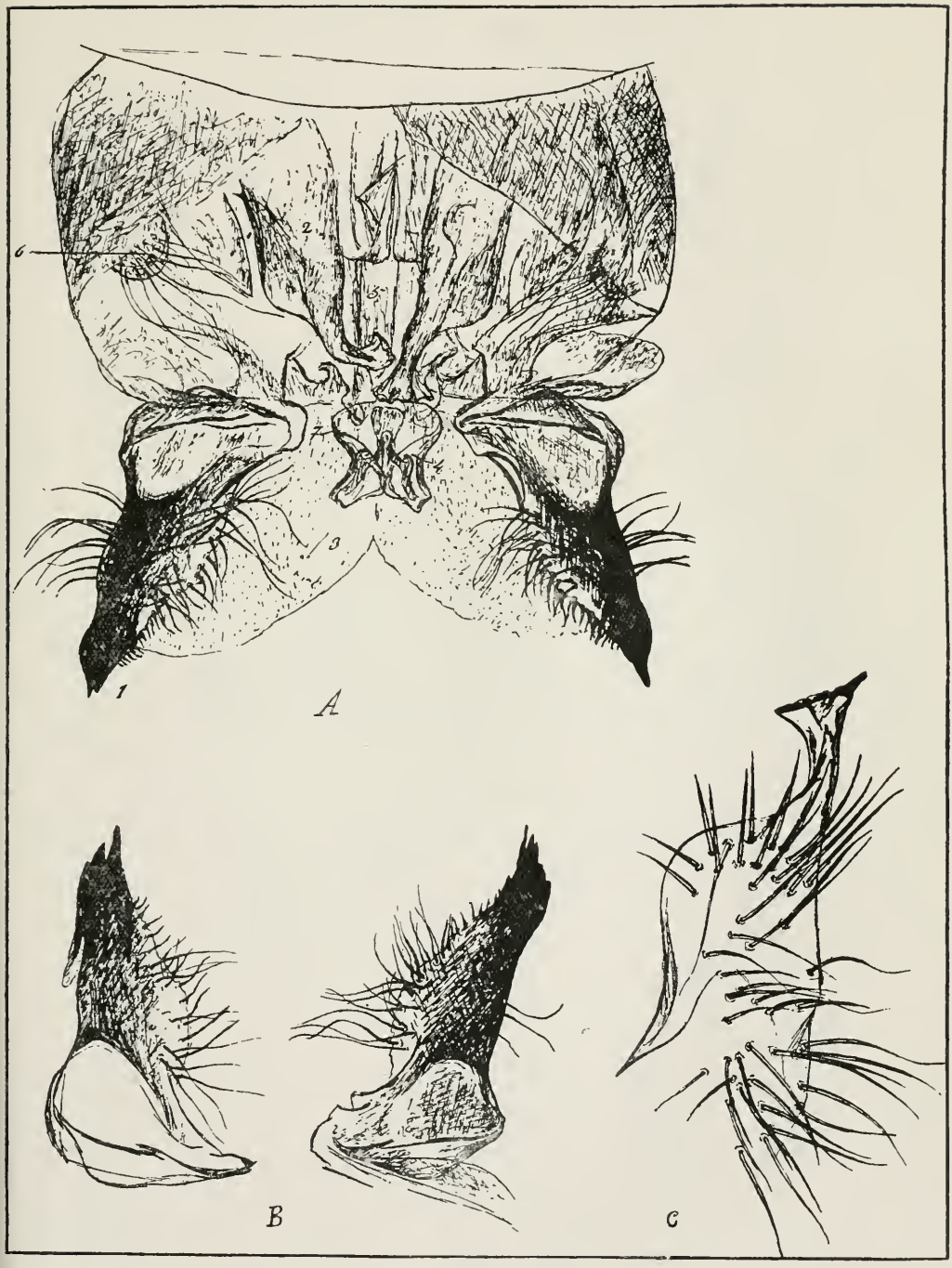


PLATE III.

Trypanosoma congolense.

Figs. 1 to 12. Parasites of the ox Couto.

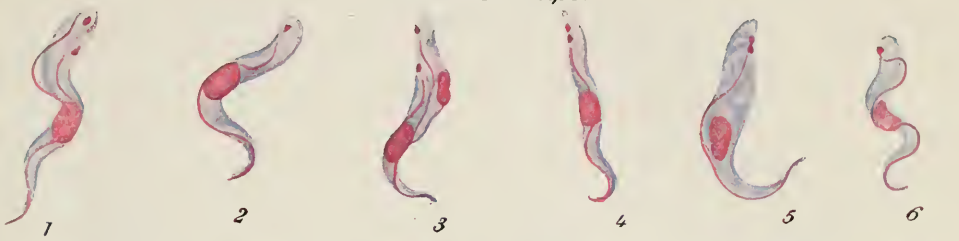
Figs. 1 to 4. Parasites in the rat.
Figs. 5 to 9. Parasites in the dog.
Figs. 10 to 12. Parasites in the monkey.

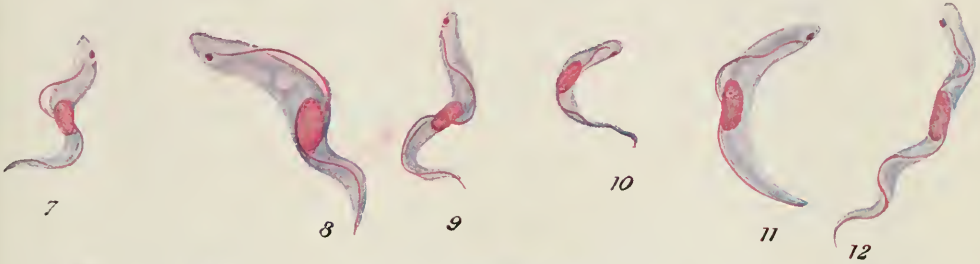
Figs. 13 to 25. Parasites of the mule Figueira in the monkey.

Figs. 26 to 32. Parasites of the ox Lima in the rat.

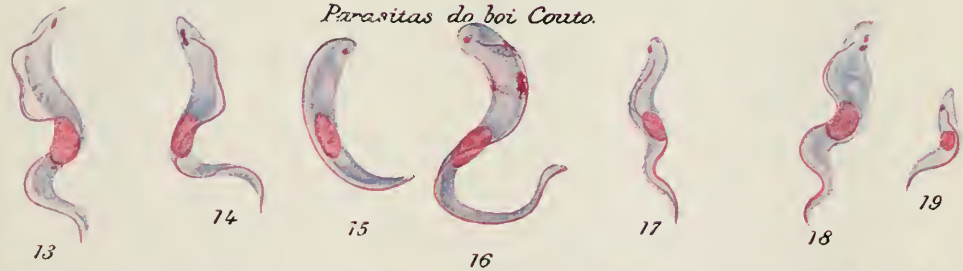
Tripanosoma congolense

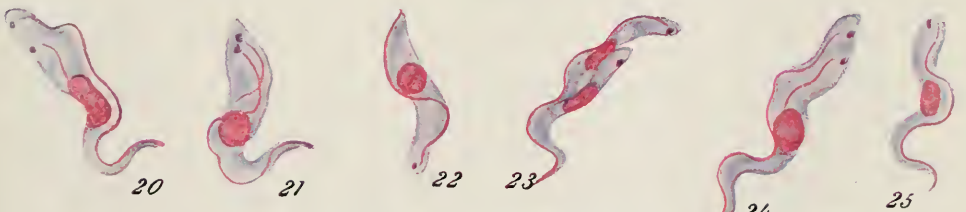
Ilha do Principe.





Parasitas do boi Couto.





Parasitas da mula Figueira.

Parasitas do boi Lima.

PLATE IV.

Trypanosoma uniforme.

Figs. 1 to 14. Parasites of the ox Pantaleão; original infection.

Tripanosoma uniforme

Ilha do Principe

Parasitas do boi

PLATE V.

Trypanosoma gambiense.

Figs. 1 to 17. Examples of the long variety of the island of Principe (var. *Principense*).

Figs. 1 to 7. Long forms in the guinea-pig.

Figs. 8 and 9. Long forms in the rat.

Figs. 10 to 12. Intermediate forms in the guinea-pig.

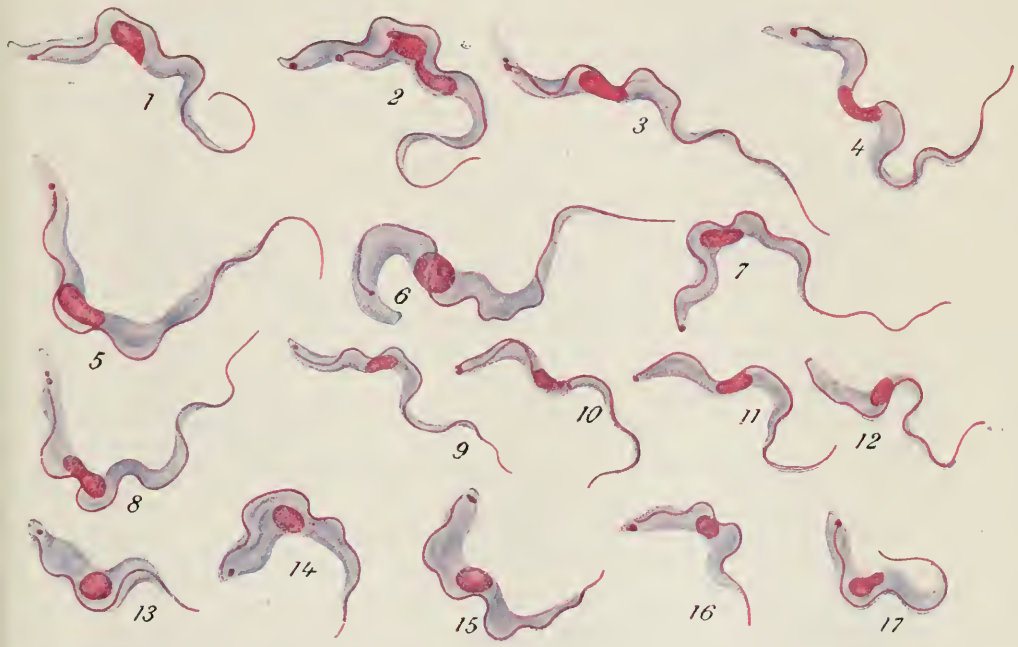
Figs. 13 to 16. Short forms in the guinea-pig.

Fig. 17. Short form in the rat.

Figs. 18 to 23. Specimens of the *T. gambiense* (common), from a patient on the island; blood of a monkey inoculated.

Figs. 24 to 28. Specimens of the *T. gambiense*, case imported from San Salvador (Congo); blood of a monkey inoculated.

Tripanosoma gambiense



Variedade comprida = Ilha do Principe

Tripanosoma gambiense comum = Ilha do Principe

Tripanosoma gambiense comum = Congo Portuguez

PLATE VI.

FLAGELLATES OF NATURAL INFECTION OF THE GLOSSINA IN PRINCIPE.

Nos. 1 to 4. Intestinal forms of the glossina No. 13, probably belonging to the cycle of development of the *T. gambiense.*

Figs. 1 and 2. Narrow and elongated forms.
Fig. 3. Thick form, with dense protoplasm.
Fig. 4. Form of involution.

Nos. 5 to 13. Intestinal forms from the glossina No. 171, probably of the same nature as the preceding.

Figs. 5, 6, 7, and 11. Forms analogous to those described by the authors for the *gambiense.*
Figs. 8, 12, and 13. Involutive phases.
Fig. 9. Fragment of rosacea of multiplication.
Fig. 10. Figure simulating a phenomenon of conjugation.

Nos. 14 to 17. Intestinal forms of glossina No. 94.

Figs. 14 and 17. Phases of multiplication.
Fig. 15. Involutive form in the phase of curling up.
Fig. 16. Thick form, simple.

Nos. 18 to 22. Intestinal forms of glossina No. 195, similar to the hematic forms of the *T. congolense.*

Nos. 23 to 30. Intestinal forms of glossina No. 196.

Figs. 23 to 28. Broad forms, with abundant and vacuolized protoplasm, in various phases.
Fig. 29. Form of aberrant segmentation (?).
Fig. 30. Fragment of a rosacea of multiplication.

Flagelados da infecção natural das glossinas da Ilha do Principe

PLATE VII.

HERPETOMONAS OF THE *Tabanus congolensis* AND *T. tæniola.*

Figs. 1 to 13. Forms of the gregarinic series.

- Figs. 1, 2, 3, and 4. Simple forms with short flagellum.
- Figs. 5 and 6. Forms with double flagellum.
- Fig. 7. Form with flagellum bi-radicular.
- Figs. 9, 10, 11, and 12. Forms of division.
- Fig. 13. Group of gregarinic forms, without free flagellum.

Figs. 14 to 17. Encysted forms.

- Figs. 14 and 15. Fixed encysted forms.
- Figs. 16 and 17. Free cysts (mature forms).

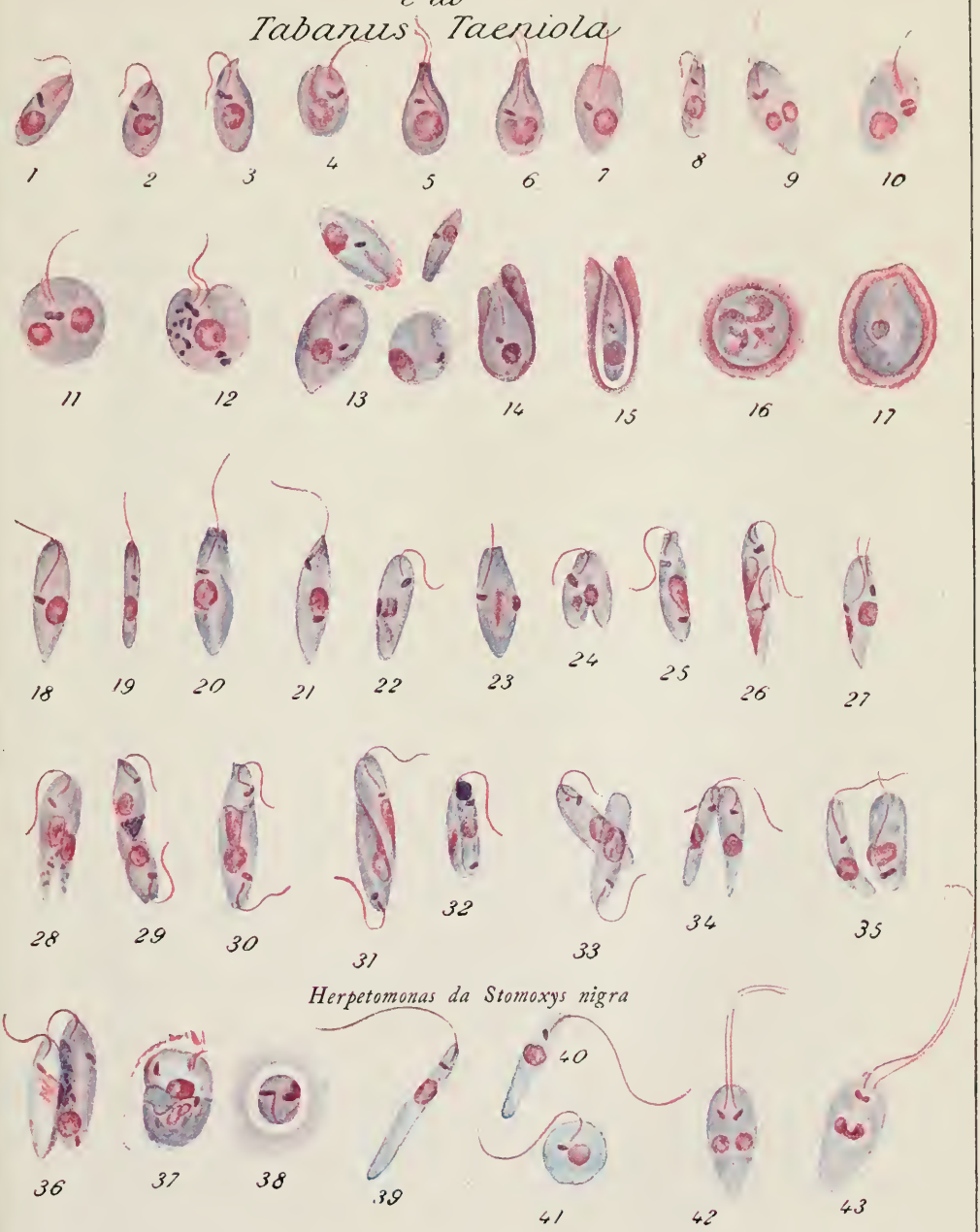
Figs. 18 to 38. Free forms of the monadic series.

- Figs. 18 and 19. Male (or neuter ?) forms.
- Figs. 20 to 23. Female forms.
- Figs. 21 and 22. Process of formation of the micro-nucleus of one of the daughter-forms at the expense of the nucleus of the parent parasite.
- Figs. 24 to 34. Different states of division, showing the orientation of the plane of cleavage and the process of throwing off the daughter-forms.
- Figs. 35 to 37. Forms of copulation and conjugation.
- Fig. 38. Involutive form (?).

HERPETOMONAS OF THE *Stomoxys nigra.*

Figs. 39 to 43. Herpetomonic forms of the *Stomoxys nigra.*

Herpetomonas da Tabanus Congoiensis
e do
Tabanus Taeniola



Herpetomonas da Stomoxys nigra

APPENDIX

NOTE.—What follows is an Order in Council having the force of law, and embodies the recommendations made by the Sleeping Sickness Commissioners in the island of Principe prior to their dissolution as a body (*vide* chapter iv. of their Report, "Sanitary Future of the Island").

Up to the date of this Decree, nine months subsequent to the conclusion of those medical officers' labours, no fresh cases of the malady have been recorded, nor has the glossina reappeared in any part of the island.

But as a precautionary measure against any fresh invasion from other countries, the Portuguese Government have issued this Decree, with a view to safeguarding the inhabitants of the island by means of legislation enabling the authorities to take the steps advisable in every emergency.

The measures now being enforced by law should make assurance doubly sure, and are to remain operative as long as any danger of reinfection is even remotely possible.

EXTRACT FROM "DIARIO DO GOVERNO," LISBON, JUNE, 1915.

(OFFICIAL GAZETTE OF THE GOVERNMENT OF PORTUGAL.)

DECREE NO. 1,620.

MINISTRY OF THE COLONIES,
LISBON.
June 7, 1915.

In order to combat sleeping sickness, which had spread throughout Principe with such intensity that the total abandonment of the island at one time appeared imminent, the Government of the Republic of Portugal issued the Decrees of April 17, 1911, and August 17, 1913.

Thanks to the measures prescribed in those Decrees, based on rules deduced from the etiology of that deadly malady, but still more so to the intelligence and energy with which the Portuguese colonial medical officers engaged in combating it carried out their brilliant campaign, it has been possible to achieve a most notable result—namely, the practical extinction of the disease in the island with effect from October 1 last.

And that there should be no risk that so much labour and sacrifice on the part both of the State and of private individuals throughout this campaign should go for nothing, it seems advisable to maintain for a further period, to which at this moment a definite limit cannot be assigned, the Official Sanitary Brigade hitherto at work

in the island of Principe, but on a reduced scale and at less expense, without, however, prejudicing the work yet to be required of it.

And not only for the consolidation of the good results attained, but also to make it possible to improve the general salubrity of the island, and thus indirectly benefit the health of its labouring population, including in this expression both human beings and auxiliary animals, it seems very advisable to unite in a single enactment the measures prescribed in the earlier decrees cited and in arrangements subsidiary thereto. Part of these measures will be embodied herein, those which may have served their purpose or have proved either less practicable or no longer expedient being revoked.

Taking, therefore, these considerations into account, and having heard the Colonial Council and the Council of Ministers,

In the exercise of the powers conferred upon the Government by Art. 87 of the Political Constitution of the Portuguese Republic, and moved thereto by the Minister of the Colonies, I hereby decree as follows :

Art. 1.—The landing on the island of serviçaes coming from regions infected by sleeping sickness is prohibited.

Art. 2.—All persons, carriers of sleeping sickness, now in the island of Principe may, when the sanitary authority shall deem fit, convenient, and indispensable so to direct, and for the period which may to him appear necessary, be interned in the State hospital.

Clause i.—The persons referred to in this article shall pay for their hospital treatment half the charges that would be payable had they been admitted into hospital for any other malady.

Clause ii.—The cost of treatment in the case of contracted labourers shall be borne by employers, and of recognized pauper patients by the State.

Clause iii.—European sufferers from the disease may be granted treatment as out-patients, but it shall be obligatory upon the medical officer in attendance to notify the case, and to carry out all prophylactic measures applicable thereto.

Art. 3.—It is obligatory upon all medical men practising their profession in the island of Principe to notify to the Health Delegation all cases of the malady, whether known or suspected.

Sole Clause.—The greatest care in complying with this requirement is enjoined upon medical officers of agricultural estates. In the event of non-compliance, they will be liable to the penalties prescribed by law for failure to notify cases of infectious or contagious disease.

Art. 4.—No person diagnosed as suffering from sleeping sickness, whether the malady be recently acquired or of long standing, shall be permitted to leave the island of Principe except for the purpose of treatment in Europe, or to proceed to any part of Africa where human trypanosomiasis is unknown, unless the following conditions be absolutely verified :

(*a*) Good general health.

(*b*) Having been submitted, during at least four months, to a systematic specific treatment, either by atoxyl or some other drug similar in therapeutic properties.

(*c*) Examination of blood, with constantly negative results, carried out during at least three months subsequent to suspension of treatment.

(*d*) The lapse of not less than one year from time of making the diagnosis to time of intended departure from the island.

ART. 5.—The following duties are hereby imposed upon the estate owners of the island of Principe, European and native alike, or upon their managers, attorneys, or tenants:

1. The clearing up of spontaneous vegetation, herbaceous or bushy, on all uncultivated lands within the limits of the properties belonging to them, managed by them, or worked by them. Such clearing up to take place at least once a year, and whenever further advised or intimated by the sanitary authorities.

2. The prevention of the formation of so-called *capoeirões* in the lands under forest, in felled forests, or in plantations, and the destruction of all such which may come into existence before they attain large proportions.

3. The cleaning of the edges of all watercourses, great and small, as well as of all collections of stagnant water to be found on their estates, and their annual freeing from trunks, stones, bushes, or detritus of any kind which may hinder their flow or cover the surface of the water.

4. The keeping in efficient working order of all swamp drains or embankments for the regulation of the flow of streams which may have been carried out by direction of the sanitary staff in the years 1911-1914, and their completion by any small supplementary work that may have been or may subsequently be enjoined by competent authority.

5. The prevention of the re-creation of so-called *obós* which may have been felled during the period of work done towards the extinction of sleeping sickness in the northern and central regions of the island of Principe.

6. The prevention of the invasion of both old and new plantations by secondary growth to such an extent that they may return to a state of wild forest.

7. The notification of the reappearance of the glossina (sleeping sickness fly) at any part of the properties owned, immediately upon its discovery, and thereafter the furnishing of all information required by the sanitary authorities.

8. The carrying out, within the limit of time fixed, of the other prophylactic measures enjoined by the sanitary authorities.

Sole Clause.—All those who, for want of pecuniary means, duly attested as paupers by the administrative authority, or duly verified as of a physique inadequate to their execution, are unable to carry out the requirements of this article or to pay for their being carried out, shall be exempt from its operation.

ART. 6.—The rearing of cattle of any kind in herds or droves in the northern and central portions of the island is prohibited, but such may be permitted in the southern zone formed by the southern slope of the line of heights extending from the point of the Pico das Duas Cabeças to that of the Focinho do Cão, including the peaks of the Companhia da Roça do Infante D. Henrique and the Pico da Mesa.

Clause i.—Throughout the whole area of the island of Principe the rearing of swine is prohibited, and on the verbal intimation of any police or sanitary authority, any such animal found in enclosed lands shall be seized. The hunting down of wild pigs, wherever these may be found, is sanctioned.

Clause ii.—In the northern and central zones of the island of Principe the possession only of the animals indispensable for the work of the estate is permitted. Outside of working hours such animals shall be kept in huts, stables, or cowsheds, in satisfactory hygienic conditions.

ART. 7.—The importation of domestic animals from places on the African continent where the *tze-tze* fly may exist is prohibited, except for purposes of slaughter, and in no case may any such animal be made use of upon agricultural work, transport, or for any other purpose.

Sole Clause.—The animals to which this article relates must be kept in recognized cattle-sheds in the suburbs of the town, and remain subject to inspection by the sanitary authority until slaughtered.

ART. 8.—Throughout the whole area of the island of Principe it is prohibited to keep dogs without a municipal licence and without the distinctive marks prescribed by law. Any such animals found without these marks shall be liable to be destroyed by order of the sanitary authority.

ART. 9.—The sanitary inspection of all animals landed on the island of Principe under arrangements by the Delegation of Health is obligatory, and consignees, persons for whom the animals are intended, and owners of those animals, must submit them to all measures for the general sanitary welfare of the cattle on the island which the said authority may impose.

Sole Clause.—Animals found to be carriers of the trypanosome, whether of recent importation or already on the island, shall be dealt with as the Delegation of Health may determine, and it shall be competent to that authority to take all steps necessary for the combating of animal trypanosomiasis, governing its procedure both in this respect and in all others relating to the health of cattle, so far as may be practicable, by the rules for the guidance of the veterinary services in force in the province of Angola.

ART. 10.—The duties of technical direction hitherto appertaining to the Official Sleeping Sickness Brigade in Principe shall be carried out by the Delegate of Health, in addition to those at present imposed on him by law, assisted by another and a junior practitioner of the cadre of Angola-San Thomé and Principe, who may act for him in case of his temporary incapacity, both officers being responsible, each for his share in the supervision of the two zones into which the island shall be divided for this purpose. They shall further have the special duty of carefully verifying, by all means in their power, whether the disappearance of the glossina from the island is complete and unquestionable up to date of their reports.

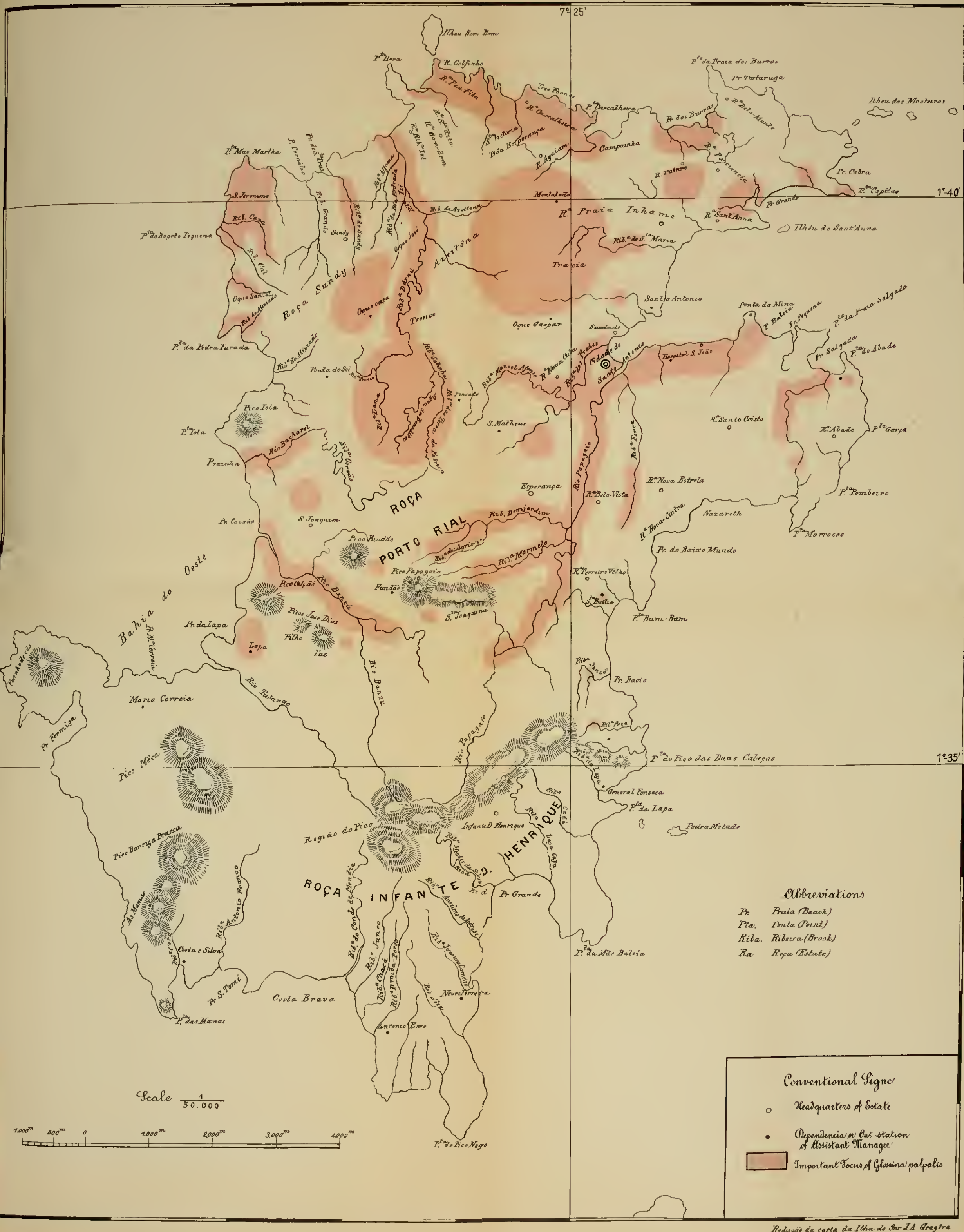
ART. 11.—In this new phase in the work falling to the lot of the Brigade the two members of the cadre who may be posted for duty to Principe shall be deemed to be members of an ordinary commission, and may be relieved on completion of the prescribed periods of service, but not at one and the same time. This is to secure that the relieving officer shall become duly instructed as regards the state of the work done or in process of execution. These practitioners will draw, over and above their ordinary pay and allowances as officers serving in the province of San Thomé and Principe, a special allowance in addition of fifty dollars per mensem.

ART. 12.—The strength of the native establishment of the Brigade shall now be thirty men, under the supervision of a European overseer, subject to the administrative control of the Delegation of Health, their clerical work being arranged for by the hospital sergeant-clerk of the Health Department. The monthly pay of the European overseer shall be seventy dollars; the sergeant-clerk shall draw a supple-

Map 1

SLEEPING SICKNESS MISSION

Distribution of former foci of the Glossina in the Island of Principe



mentary allowance of seven dollars fifty cents per mensem; and the serviçaes, who should preferably be recruited from among the men placed at the disposal of Government, shall draw, in the case of contracted labourers, the wages set forth in their contracts. The soldiers necessary for duty with the Brigade—two in number at least—will continue to be furnished from the military detachment on the island of Principe, upon requisition addressed to its commanding officer.

Art. 13.—The main objective of the Official Sanitary Brigade in the island of Principe is as follows:

1. To carry out all works for the sanitation of State lands, of municipal lands, and of those of the persons in impoverished circumstances or incapacitated, referred to in Art. 5, Sole Clause.

2. To carry out the same works upon private estates should the services of the Brigade be requisitioned, or in cases where their execution has become compulsory through non-compliance with the instructions of the sanitary authorities.

3. To destroy stray dogs and pigs.

4. To perform any other duty of prophylaxis and hygiene in which the Delegation of Health may think fit to employ it for the sanitary advantage of the island.

Sole Clause.—In any of the cases referred to in Item 2 of this article the expenses of sanitary work shall be borne by the owners of the estates benefited thereby.

Art. 14.—The Delegate of Health is empowered to lay down in detail, in agreement with the second medical officer on duty in the island, the measures to be put into practice; to correspond, upon questions relating to public health, with the administrative authority, the President of the Chamber, the curator of contracted labourers (serviçaes), the Superintendent of Customs, the head of the Health Department, and the estate owners; and he is required to make special references in every monthly bulletin upon all points relating to the disease (sleeping sickness).

Art. 15.—Besides his ordinary duties, it is incumbent upon each of the medical officers of the cadre for duty in the island of Principe—

1. To make clinical inspections of the serviçaes entering the island, and to supplement these by the necessary microscopic examinations.

2. To watch over the sanitary state of the population of the zone in his charge, so that the existence of sleeping sickness or the appearance of any fresh case of that disease shall not escape detection.

3. To carry into effect inspections and examinations of the blood of domestic animals, so as to fulfil the requirements of Art. 9 of this enactment.

4. To make himself acquainted with and verify the conditions of the various estates in the zone under his medical charge, in order to be in a position to take steps for the rigorous compliance with the requirements of Art. 5 in all its items and in its Sole Clause.

5. To issue through the Delegation of Health the notices and intimations for measures deemed necessary, indicating therein the nature of the work to be done and the period within which each piece of work shall be completed.

6. To report through the Delegation of Health to the administrative authority any contravention of the law on the part of any private individual, or of non-compliance by the latter of any intimation issued, so that the prescribed fines and penalties may be duly imposed upon the offender.

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5. To issue through the Delegation of Health the notices and intimations for measures deemed necessary, indicating therein the nature of the work to be done and the period within which each piece of work shall be completed.

6. To report through the Delegation of Health to the administrative authority any contravention of the law on the part of any private individual, or of non-compliance by the latter of any intimation issued, so that the prescribed fines and penalties may be duly imposed upon the offender.

7. To give private individuals any technical information on the subject of hygiene necessary for the success of the work required of them, and to direct the operations of the Official Brigade to the same end.

Art. 16.—The overseer of the Brigade is empowered to do all that may be laid down for him to do in the supplementary regulations to be framed under this Decree. He is not to be forbidden by private individuals free access to any lands owned or managed by them, should he require to enter them for the efficient performance of his duties or the execution of orders issued by his immediate superiors. In order to enable the overseer to move about with the greatest freedom and rapidity, he shall be provided with a permanent mount, free of all charges for feeding and treatment.

Art. 17.—The families of members of the technical establishments who may become sufferers from sleeping sickness contracted while in the service of the Official Sanitary Brigade of the island of Principe shall receive the benefits of the law of July 25, 1913, operative in Angola, likewise those of the paid members of this or the previous Brigade created under Decree of April 17, 1911, and likewise those who have or may become unfit for duty in and through the execution of their duty, as laid down in the law of June 20, 1914, in respect of persons in Portugal incapacitated in and through the public sanitary service.

Penalties.

Art. 18.—Private individuals who contravene or refuse to comply with the provisions of this law shall be subject to the following penalties :

1. Whosoever shall prevent his contracted labourers from subjecting themselves to the rules of prophylaxis and sanitary vigilance laid down in Arts. 1, 2, and 4, shall be liable to a fine which may extend from five to fifty dollars for each offence.

2. Whosoever shall contravene Arts. 6, 7, 9, and the clauses thereof respecting domestic animals, shall be punishable with a fine, which may extend from five to fifty dollars for each animal in respect of which the provision of law may not have been complied with.

3. Non-compliance with any of the obligations imposed by Art. 5 will render the offender liable to a fine of fifty dollars if, after notice has been served upon him, compliance is not made within a period of not less than fifteen and not more than ninety days, according to the extent of the work to be done. Work not done by the persons responsible will in such cases be done by the Official Brigade at the expense of the defaulter. Should the cost of these not be voluntarily met within fifteen days, execution will be taken out against the defaulter, and the account rendered shall have the force of a decree of execution.

Art. 19.—The sanitary authorities are authorized to issue notices and to file suits for non-compliance with the provisions of this Decree, recovering the respective fines.

Clause i.—Notice shall be given in writing, or verbally in presence of two witnesses, the period within which the acts intimated shall be performed being named, and intimation of the fines similarly.

Clause ii.—When the defaulter does not voluntarily pay the fine within the period of fifteen days from date of its imposition, its recovery shall be effected according to the process of correctional police, the respective intimation having the force of a *corps de délit*.

SLEEPING SICKNESS MISSION

Outline of the principal Sanitation Work done

Esboço feito sobre a carta dos Ilhas desenh. J. Augusto Gragira de Paula (1911) por J. Firmino Sant'Anna

Clause iii.—Whenever the fine imposed according to correctional police process is not credited to the State Treasury within eight days from the sentence or order passing into effect, the fine shall be commuted, by order of the Judge, against which no appeal shall lie, into an execution upon property, and in default of realization for want of assets, into a sentence of disciplinary hard labour on a scale equivalent to fifty dollars per diem.

Clause iv.—The Public Ministry is the competent authority for the commutation in judgment, either of the processes referred to in Clause ii. of this Article, or of the execution referred to in Art. 18, Clause iii., for which purpose the sanitary authority shall send him the required informations, duly drawn up.

ART. 20.—The Sleeping Sickness Brigade created under Decree of April 17, 1911, Art. 17, is hereby dissolved.

ART. 21.—The Governor of the Province of San Thomé and Principe will issue, by notification, the supplementary regulative provisions of this Decree, and is authorized to expend the sum of five thousand dollars per annum upon the maintenance of the said Brigade.

Let the Minister of the Colonies take cognizance and duly execute.

Given at the Palaces of the Government of the Republic, and published on June 7, 1915.

JOAQUIM TEOFILO BRAGA.
JOSÉ JORGE PEREIRA.

Baillière, Tindall & Cox, 8, Henrietta Street, Covent Garden

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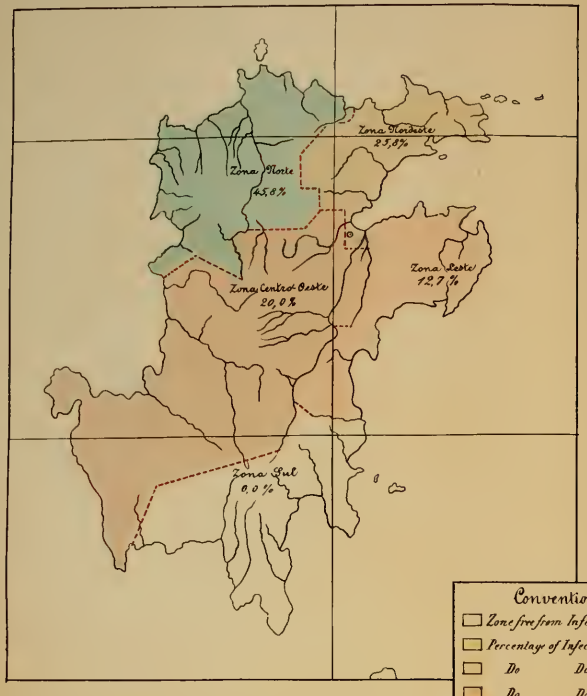
G SICK

SLEEPING SICKNESS MISSION

Island of Principe

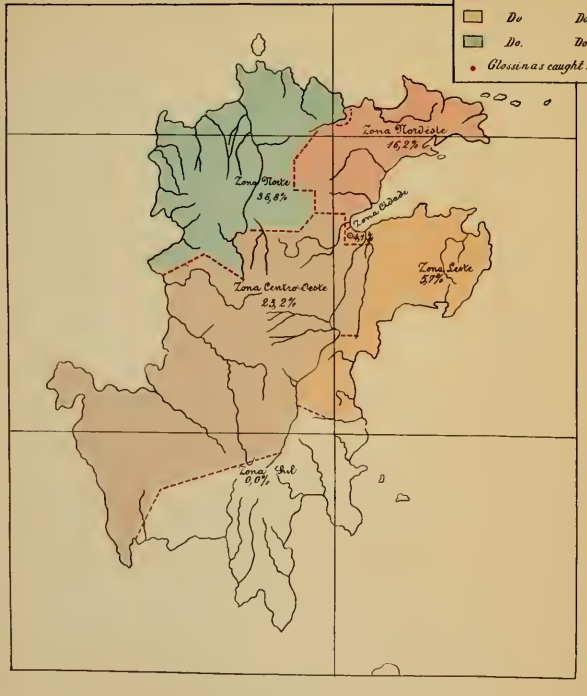
I

Infection of the Island, by Zones, in 1909 (Correia Mendes)



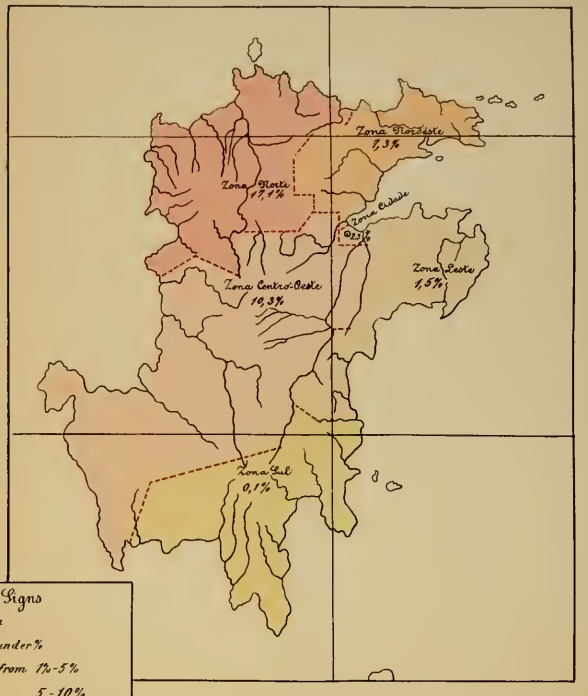
II

Infection of the Island, by Zones, in 1911 (Bruto da Costa)



III

Infection of the Island, by Zones, in 1913, May (Bruto da Costa)

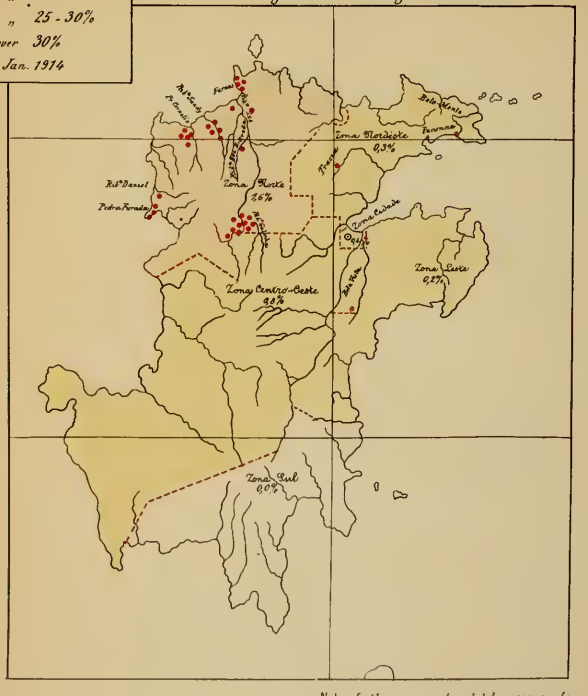


Conventional Signs

- Zone free from Infection
- Percentage of Infected under %
- Do Do from 1%-5%
- Do. Do. „ 5-10%
- Do Do „ 10-15%
- Do Do „ 15-20%
- Do Do „ 20-25%
- Do Do „ 25-30%
- Do. Do. over 30%
- Glossinas caught since Jan. 1914

IV

Infection of th Island, by Zones, in June 1914. Last Glossinas caught.



Note. In this map, each red dot corresponds to a glossina

Drawn by J. Firmino Sant'Anna

SLEEPIN